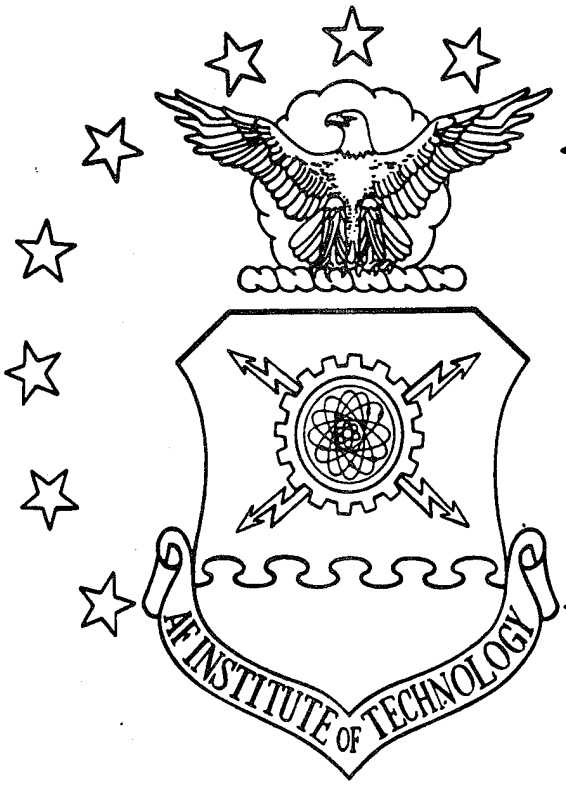

SCHEDULE MANAGEMENT COMPETENCIES FOR DEPARTMENT OF DEFENSE PROGRAM MANAGERS

THESIS

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AFIT/GSM/LAP/95S-9

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THESIS

Presented to the Faculty of the Graduate School of Logistics and Acquisition Management

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Systems Management

Jeffrey F. Brown

Captain, USAF

September 1995

Acknowledgments

I have seldom encountered a task where, upon its completion, I can honestly say, "I alone was responsible for its success." This thesis was no exception. Several people gave unselfishly of their time and energy to ensure its completion. I would like to take this opportunity to thank them. First, Major Kevin Grant was a great help in providing me the initial pointing vector to focus my thesis and continual guidance to keep me on track. He inspired critical thinking and was of immense help in resolving the numerous problems which inevitably arise from such a noteworthy endeavor.

I also offer sincere appreciation to AFMC/XRMA for their database support. Special thanks to Captain Mike Farmer who tracked down the names and addresses of 573 program managers for the survey, to the folks at ASC/CY and ESC/CY who verified the addresses, and to Colonel Robert Helt for sponsoring this research. The survey would have gone nowhere without their support.

The AFIT librarians were especially helpful in my quest for knowledge. They cheerfully assisted in my very extensive literature review and helped me find numerous documents critical to the research.

Finally, I'm indebted to those who sacrificed the most for this research -- my wife Lucy and my three children, Michael, Stephanie, and Stephen who endured many months of school, sports, and social events in my absence. Their patience through the many long days of work often exceeded mine, yet they continued to encourage me to the end.

Jeffrey F. Brown

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Abstract

With ongoing public scrutiny of defense system acquisitions, due to numerous program failures resulting from cost and schedule overruns, now, more than ever, cost and schedule-management competencies are critical to program success. This research examined the schedule-management competencies required of defense program managers.

A schedule-management competency model was developed from a foundation of past research. The model was evaluated through a mail survey of 484 intermediate and senior level military program managers assigned to Air Force Materiel Command. The results provided by 243 respondents indicate that 25 of the 28 competencies in the model were valuable to program managers and that they generally rely more on understanding schedule-management concepts than they do on being able to complete the tasks themselves. Data analysis identified differences in the perceived importance and frequency of use based on acquisition phase, primary responsibility, and grade level.

The results of this study have direct implications for the development of education and training programs for defense program managers. These programs can be improved by focusing on those competencies found most valuable to experienced program managers.

SCHEDULE-MANAGEMENT COMPETENCIES FOR DEPARTMENT OF DEFENSE PROGRAM MANAGERS

I. Introduction

Background

We live in an age of great uncertainty. Violence and war are constantly threatening the stability of peace throughout the world. One way to combat this threat is through military might. Yet military strength is expensive. By the end of the 1970s, the United States defense budget was $150 billion a year (Gansler, 1989:1). As a result of significant growth of this budget during the 1980s, national security has become an increasingly important and controversial issue. Over one third ($92 billion in 1993) of the dwindling Department of Defense (DoD) budget is applied towards research, development, and procurement of systems in support of national defense (Cheney, 1993:143). While the defense budget continues to decrease, public scrutiny is on the rise. Cost overruns, schedule slippages, and multi-million dollar defense contract failures have pushed public involvement to an all-time high.

Within the DoD, acquisition of military weapon systems is accomplished by specialist personnel working in System Program Offices (SPOs). Program Managers responsible for coordinating the efforts of these specialists are also responsible for ensuring that the acquisition programs achieve established cost, schedule, and

growth were technical uncertainty and scope changes after the developmental phase. (Perry et al, 1971:16)

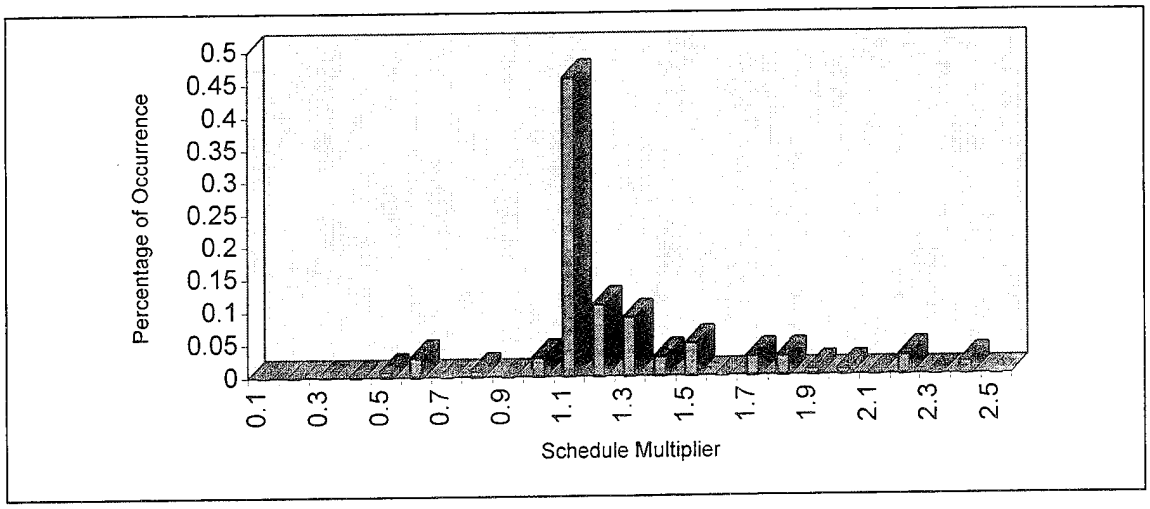

Figure 1. Schedule Performance: 1971 Study (Perry et al, 1971:8).

In 1980 another study was conducted to determine if the acquisition cycle had lengthened over the preceding three decades and whether there were any practical ways to shorten the acquisition cycle without causing undesirable program outcomes (Smith and Friedmann, 1980:v). One of the interesting conclusions of this research was that the "time from beginning of full-scale development to first flight has remained remarkably constant" over the three decades (Smith and Friedmann, 1980:v).

Drezner and Smith conducted a study in 1990 to understand the issues associated with measuring acquisition schedules, evaluating trends in program duration, and identifying the factors affecting that duration (Drezner and Smith, 1990:1-2). This study identified sixteen factors (see Table 1) believed to affect the original plan or cause deviations to the program once underway, or both. The authors conducted a non-statistical case-study of ten major programs to determine the extent that these factors

affected schedule performance. On average, the programs surveyed incurred a 33% slip in schedule length over the original plans. They also concluded that only one of the top four factors accounting for the largest slip (technical difficulty) was under the control of the program manager (Drezner and Smith, 1990:vi-vii).

Table 1. Factors Affecting Program Schedules.

• competition	• concurrency	• funding adequacy	• separate contracting
• funding adequacy	• prototype phase	• service priority	• external guidance
• joint management	• program complexity	• technical difficulty	• contractor performance
• external event	• concept stability	• funding stability	• requirements stability

(Drezner and Smith, 1990:21-24)

History of Defense Program Failures

Cost and schedule overruns are not new. *Creating a Professional Acquisition Workforce* by Congressman Nicholas Mavroules provides a historical perspective of defense system acquisition problems. In his article, Representative Mavroules states that the defense acquisition failures date back to the Navy's first contract for a warship, the USS Constitution, which overran by 175 percent (Mavroules, 1991:15). More recent examples of DoD acquisition scandals and failures resulting from cost overruns and schedule delays include the Navy A-12 attack jet, the Air Force C-17 transport, the Navy and Air Force Advanced Tactical Airborne Reconnaissance System (ATARS), the Tri-Service Stand-off Attack Missile (TSSAM), and the joint National Aeronautics and Space Administration, Air Force, and Navy sponsored National Aerospace Plane (NASP).

The U.S. Navy's A-12 radar-evading attack jet was terminated in January 1991 for contractor default. Significant contributing factors to that program's failure included

the inappropriate use of a fixed price contract for development and the uncertainty created by the improper use of cost and schedule control data for reporting program estimates at completion (Christensen and Heise, 1993:7). McDonnell Douglas and General Dynamics filed a termination for convenience claim for $1.1 billion and in December 1994 the court ruled the government erred in terminating the contract (Rosenberg, 1995:7).

The U.S. Air Force is counting on the C-17 to modernize its tactical and strategic airlift capability. But cost overruns caused by a prolonged flight test program have jeopardized the McDonnell Douglas development program (Smith, 1993:30). Additionally, key Air Force officials, including the former program manager, were disciplined for improperly advancing the prime contractor nearly $500 million in premature progress payments (Morrocco, 1993:62). McDonnell Douglas has a claim for over $1 billion for costs incurred on the program.

Under fire from both Defense Secretary Les Aspin and congress about the C-17 transport program, the Air Force terminated the Advanced Tactical Airborne Reconnaissance System (ATARS) program. According to an internal Pentagon analysis, escalating costs resulted in a $1.7 billion research, development, and production shortfall further causing unacceptable production delays (Fulghum, 1993:60).

For years the U.S. Air Force faithfully supported the stealthy Tri-Service Stand-off Attack Missile (TSSAM) despite an approximate $1 billion cost overrun and uncertainty over continued Navy and Army participation. In February 1995 the Air Force sent a stop-work order to Northrop Grumman officially terminating the 80 percent

complete program (AWST, 1995:29). Termination was "for convenience of the Government," giving relatively favorable terms to Northrop Grumman which had already written off about $620 million due to schedule delays (Capaccio, 1995:4).

The National Aerospace Plane (NASP) was conceived by the Air Force, Navy, and National Aeronautics and Space Administration as a futuristic, manned, hypersonic, high-altitude air vehicle. Public and congressional scrutiny over the NASP resulted in program re-direction in May 1993 following an estimated cost growth of $12-15 billion, "roughly three times the initial estimates" (Scott, 1993:22). Technical risks continue to cause schedule delays and increase the overall program costs (Kandebo, 1993:33).

The two key indicators of program failure for all the above examples are unfavorable cost and schedule variance. Schedules drive most projects, and more problems are caused by an unrealistic schedule than any other reason. Changes in the schedule usually start with small, almost indiscernible alterations that go unnoticed by all but the most astute managers. For example, a slip in the delivery of a test plan may make the test program late because long lead actions were not taken. This usually occurs early in the development and little attention is paid to its potential impact. Slips tend to become more frequent as development progresses until it becomes obvious that there is a major programmatic problem. Management then realizes it will be unable to meet the planned schedule.

Professional Acquisition Corps

Since World War II, there have been numerous committees that have looked into the problems of military acquisition from the Hoover Commissions of 1949 and 1955 to the Packard Commission of 1986. In 1969, the Deputy Secretary of Defense David Packard initiated a number of actions aimed at improving the management of defense systems acquisition process and gaining control of systems acquisition costs (Acker, 1993:20). In July 1971, Packard established the Defense Systems Management School (now college) to prepare government personnel for assignments in project management career fields. In 1972, the Commission on Government Procurement – the first ever to concentrate exclusively on procurement -- made 149 recommendations. Among the principal findings of the commission was that there was no systematic government-wide effort for studying ways to improve the procurement process (Acker, 1993:25). In June 1985, President Ronald Reagan named former Deputy Secretary of Defense David Packard to head a Blue Ribbon Commission on Defense Management. The Packard Commission final report submitted in June 1986 found the acquisition workforce to be undertrained, underpaid, and inexperienced (Cheney, 1989:12). Congress acted on this most recent commission by passing the Defense Acquisition Workforce Improvement Act of 1990 (DAWIA). As a result of this legislation, the DoD established a professional acquisition corps with training and experience commensurate with the varied responsibilities of the acquisition workforce.

The DoD implemented DAWIA under the Department of Defense Directive (DODD) 5000.52, Defense Acquisition Education, Training, and Career Development Program, and DOD 5000.52M, Career Development Program For Acquisition Personnel. These documents require the armed services to establish and maintain systems which certify acquisition personnel at various levels, based on their acquisition experience, education, and training (DODD 5000.52, 1991:2). The Air Force certification program is currently called the Acquisition Professional Development Program (APDP).

The APDP certification criteria are general in nature. While there are three levels of certification, there are no explicit requirements for training, education, or experience for program managers in specific areas like schedule-management. Therefore, the tools to manage education and training programs at a detailed level are limited. Competency models in specific areas like schedule-management would provide the needed tools for creating and managing programs to develop acquisition workforce competence. *Merriam Webster's Collegiate Dictionary* defines the word competent as:

1. proper or rightly pertinent;
2 having requisite or adequate abilities or qualities;
3. legally qualified or adequate (Webster, 1993:234).

For the purposes of this research, the term competency is interpreted as a capability required for proficient program management. When program managers are proficient, they possess the skills and knowledge necessary to successfully complete a task or understand a particular aspect of schedule-management. (Note: The terms program manager and project manager are used interchangeably throughout this research, as are program management, acquisition management, and project management.)

Defense Acquisition Workforce Improvement

In Secretary of Defense Dick Cheney's January 1993 report to the President, he states programs established under DAWIA provide "scholarships, tuition assistance, internships, cooperative education, management information, education and training, the Defense Acquisition University (DAU), and a senior acquisition course of study" (Cheney, 1993:167). The DAU is responsible for centrally managing acquisition training resources and is standardizing competency-based, mandatory acquisition training. DAU works in conjunction with functional boards to identify competencies and translate needs to courses. Functional boards are established for each of the seven functional acquisition areas (see Table 1) to provide oversight of management and career program execution (AIAA, 1993:352).

Table 2. Acquisition Functions and Career Fields.

ACQUISITION FUNCTIONS	CAREER FIELDS
◦ Acquisition Management	◦ Program Management ◦ Communication-Computer Systems
◦ Procurement and Contracting	◦ Contracting ◦ Purchasing ◦ Industrial Property Management
◦ Systems Planning, Research, Development, Engineering, and Test	◦ Systems Planning, Research, Development, Engineering ◦ Test and Evaluation Engineering
◦ Production	◦ Manufacturing and Production ◦ Quality Assurance
◦ Acquisition Logistics	◦ Acquisition Logistics
◦ Business, Cost Estimating, and Financial Management	◦ Business, Cost Estimating, and Financial Management
◦ Auditing	◦ Auditing

(AIAA, 1993:352)

DAWIA has expanded this list to the following twelve career fields:

1. Program Management
2. Communications/Computer Systems
3. Contracting

4. Purchasing
5. Industrial Property Management
6. Systems Planning, Research, Development and Engineering
7. Test and Evaluation Engineering
8. Manufacturing and Production
9. Quality Assurance
10. Acquisition Logistics
11. Business, Cost Estimating, and Financial Management
12. Auditing

Even with the identification of these career fields and a rigorous training process in place, mandatory acquisition training continues to focus on general program management skills. Research focusing on schedule-management competencies will provide the necessary perspective to tailor this acquisition training providing a curriculum centering on this important and essential proficiency.

Accurate identification of what program managers need to know and do can maximize the benefit of time and money spent on education and training programs. For many program managers, formal schedule-management training may be limited to the few hours provided during general acquisition courses. However, for an aspect of program management as critical as managing schedules, these overviews may not be sufficient.

Previous research examining cost management competencies of program managers was conducted by Baxter and Bolin. This research reported the following:

> "Although the criteria of experience, education, and training are necessary to reflect an employee's exposure to various aspects of the acquisition process, they may not be sufficient to distinguish the qualifications of one acquisition professional from another, and they may not accurately reflect the demands placed on program managers in their day-to-day activities. These criteria simply measure attendance at professional development courses and job locations; they do not measure a person's competence in acquisition activities. Incorporation of competencies into the education, training, and certification systems would pull employees to the level of competence needed to successfully manage complex acquisitions. In other words, the standards governing service needs should not be driven by what the services currently have or what the training/education system is currently able to provide. The standards need to originate

from the demands that are placed on acquisition personnel in their day to day activities." (Baxter and Bolin, 1994:9)

Cost and schedule-management are two very important competency areas which program managers must master. This research will identify those competencies necessary for schedule-management proficiency. This research is based on the premise that education, training, and experience are necessary for developing competence. Although quantifying competency is difficult to do, identifying the required competencies is feasible and essential for the purpose of developing education and training programs. This list of required competencies can also be used as certification criteria.

Problem Statement

The 1989 Defense Management Report to the President clearly states the general problem area addressed by this research:

> "The defense acquisition workforce mingles civilian and military expertise in numerous disciplines for management and staffing of the world's largest procurement organization. Each year billions of dollars are spent more or less efficiently, based on the competence and experience of these personnel. Yet, compared to its industry counterparts, this workforce is undertrained, underpaid, and inexperienced. Whatever other changes may be made, it is vitally important to enhance the quality of the defense acquisition workforce -- both by attracting qualified new personnel and by improving the training and motivation of current personnel." (Cheney, 1989:12)

In February 1989, President George Bush directed the Secretary of Defense, Dick Cheney to develop a plan that would make substantial improvements in the defense department. The resulting report introduced an initiative to improve the DoD management of civilian and military personnel including "establishing a dedicated corps of military officers within each military department, who will be career acquisition specialists" (Acker, 1993:309). While some improvements have been made since the

Packard Commission concluded nearly five years ago, its major recommendations have yet to be implemented. As the Packard Commission observed, "each Service has made strides in managing its officer personnel to meet this challenge" (Cheney, 1989:13). While it is clear none of the Services has yet gone far enough, each are striving to increase the professionalism of their procurement workforce.

Models identifying the competencies required of DoD program managers could provide valuable information for establishing certification criteria and for designing education and training programs for Defense program managers. This research evaluated competencies for the schedule-management area. For purposes of this research, intermediate and senior level program managers are defined as occupying positions coded as APDP Program Management Level II and Level III, respectively. Using this definition, a Level II program manager must have at least two years acquisition experience, and a Level III program manager must have at least four years acquisition experience.

Research Questions

1. What schedule-management competencies are of value to intermediate and senior level DoD program managers?

    A. What schedule-management competencies are perceived to be important by program managers?

    B. How frequently are specified schedule-management competencies used by program managers?

2. Is there significant variance in the competencies required of subgroups of this population?

    A. Is there significant variance in the competencies valued by those working in different phases of system acquisition?

B. Is there significant variance in the competencies valued by those working with different primary responsibility?

C. Is there significant variance in the competencies valued by those in different grades?

Scope

Although competencies in a wide spectrum of disciplines such as engineering, contracting, logistics, and financial management contribute to program management success, this study focused on a single area within the broader discipline of program management. In particular, this study focused on identifying the schedule-management competencies valued by intermediate and senior level military program managers below the rank of brigadier general. What schedule-management competencies are perceived to be important by program managers and how frequently are these skills used? Competencies were also evaluated based on the demographic subgroups of management education, type of organization, acquisition phase, program activities, and current grade.

Key Terms

Appendix A contains a glossary of key terms taken from the *Career Development Program For Acquisition Personnel* (DoD 5000.52-M, 1991) and *Glossary: Defense Acquisition Acronyms & Terms* (DSMC, 1991).

Summary

Public disgrace and program failures such as those encountered on the Air Force C-17 and the Navy A-12 programs have plagued the Department of Defense for years, resulting in negative publicity and increased public observation. Numerous review committees have attempted to improve the process and structure of the defense

acquisition system. In addition to the process itself, recent initiatives have also focused on the people involved in DoD acquisition. There has been a concerted effort to improve the quality of the acquisition workforce through legislation such as DAWIA and service initiatives such as the Air Force's APDP. Education and training play a major role in this improvement process. In order to maximize education and training benefits, it is critical these programs focus on the tools that will be most valuable to program managers in their jobs. This thesis was an attempt to address the schedule-management competencies required of Air Force program managers so that the proper emphasis can be applied to these education, training, and certification programs.

Chapter 2 documents efforts made to date to improve the acquisition workforce and to identify the competencies required of program managers. Studies of program management skills and competencies are discussed, as are the few studies that address schedule-management directly. Chapter 3 describes the method used to develop the competency model, the sampling approach, survey instrument development and test, and the data analysis procedures. The findings and results of the analyses and statistical tests are provided in Chapter 4. Chapter 5 presents the conclusions of this research and recommendations for further study.

II. Literature Review

Overview

Cost and schedule growth are not uncommon in the acquisition of defense systems and are addressed often in literature. Nonetheless, there is still confusion over what factors cause these undesirable program failures and whether or not these factors can be controlled. This literature review begins with a brief description of DoD program management followed by a review of general management models presented chronologically covering both private sector and government research. This review of applicable literature and schedule-management models will provide the basis for development of a schedule-management competency model, to be addressed in Chapter 3, Methodology.

DoD Program Management

Eric Jenett describes project management as the "planning, scheduling, and subsequent management and direction of the time phased pattern of application of resources (time, dollars, people, equipment, material), skills, and knowledge to the execution (completion) of the various components and segments of a project" (O'Brien, 1981:305). A project has a single, definable purpose with an end-product or results, which is usually specified in terms of cost, schedule, and performance requirements. Government projects generally contract for the "end-product" with a project staff of functional personnel responsible for achieving the program objectives. Furthermore,

project management utilizes the "systems approach" to management through the use of these functionally controlled personnel (Kerzner, 1979:2).

When the contract for a program is negotiated and signed, it represents -- in an implied sense -- an agreement between the customer (government) and the provider (contractor). This agreement does not relieve the government of the responsibility for meeting program objectives. The government program manager must manage, direct, and control the program so that cost, schedule, and performance goals are met (Acker, 1993:87). Ultimate responsibility for its success (and failure) rests squarely on the government and its program manager.

A critical factor in program success is organizing the program, including the people, effort, and the system itself. Definition of the system hierarchy permits allocation of functional requirements and assignment of responsibility. The work breakdown structure (WBS) then defines all tasks to be performed and their relationship to the program organization and system hierarchy. The government program manager must be keenly aware of how the contractor is managing the program to include how the contractor allocates resources, estimates the duration of tasks, schedules and authorizes work, and evaluates its performance against planned cost, schedule, and technical objectives.

Stuckenbruck describes why the job of project manager has become so difficult in one word -- "complexity." The project manager is responsible for budgeting cost control, schedules, resource allocation, technical quality, and client, customer, or public relations

(Stuckenbruck, 1981b:20). And yet, the method of choosing project managers has been approached rather casually in industry (Stuckenbruck, 1981a:66). Normally, "the project manager and his staff are selected from functional areas within the company, or from other projects which are phasing down" (Baumgartner, 1963:12). Regardless of their background, project managers must receive the necessary education and training in order to become proficient. Project managers who have the "right stuff" for effective leadership probably acquired these competencies by managing through trial and error, often with some help from mentors and through formal training (Einsiedel, 1987:55-56). Hersey and Blanchard and Simon all suggest that knowledge and skills can be learned to give the manager the foundation for success (Hersey and Blanchard, 1977; Simon, 1976). Substantial research has been conducted to assess the appropriate curriculum. The following two sections review private sector and government studies related to the topic of project management training and education.

Private Sector Research

Researchers in the private sector have conducted studies and analyses in various project management related areas. Several pertinent studies are presented here in chronological order.

Mueller

Frederick Mueller examined the primary job tasks of industry project managers and the relationships existing between their technical specialty, formal training, and job

tasks. The analysis of the data from the respondents indicated that there existed eight primary job tasks listed in order of importance:

1. Field supervision
2. Estimating and bidding
3. Job planning and scheduling
4. Purchasing
5. Written communications
6. Expediting
7. Contract administration
8. Inspection and punch lists (Mueller, 1980:45).

The research further revealed that the respondents spent between 77% and 80% of their working time performing these eight primary job tasks. The study also identified a number of significant deficiencies in the training of project managers including: job planning and scheduling, contract administration, critical path method, and cost control (Mueller, 1980:46).

Baker and Wilemon

Thamhain and Wilemon examined the degree of conflict experienced in the four life-cycle phases. Results of the research included:

1. Disagreements over schedules result in the most intense conflict situations over the entire life cycle of a project.

2. The mean conflict intensities over the four life-cycle stages reveal the following rank order:

A. Project Formation

1. project priorities
2. administrative procedures
3. schedules
4. manpower resources
5. cost
6. technical conflicts
7. personality

C. Main Program Phase

1. schedules
2. technical conflicts
3. manpower resources
4. project priorities
5. administrative procedures
6. cost
7. personality

B. Build-up Phase

1. project priorities
2. schedules
3. administrative procedures
4. technical conflicts
5. manpower resources
6. personality
7. cost

D. Phase-out

1. schedules
2. personality
3. manpower resources
4. project priorities
5. cost
6. technical conflicts
7. administrative procedures

3. Suggestions for minimizing detrimental conflict in each of the four phases (Baker and Wilemon, 1980:115).

Levinson

Harry Levinson examined personality criteria that could be used to select executives (Levinson, 1980:113-120). Although Levinson's work was not directed toward the military program manager, senior managers in both industry and the DoD may rely on similar skills. Levinson conducted no formal research to validate his model and in fact states, "I make no claim for statistical validation of the dimensions or that the scales represent equal intervals or accurate measures. The dimensions, therefore, should be used qualitatively, not as an arithmetic index" (Levinson, 1980:119). Levinson's 20 "Dimensions of Leaders' Personalities" are listed in Table 3. Levinson's 20 Dimensions of Leader's Personalities.. This list is not intended to be a set of criteria to which people are held, but rather, it is a way of calling attention to and examining facets of dimensions of personality that relate to executive success" (Levinson, 1980:119).

Table 3. Levinson's 20 Dimensions of Leader's Personalities.

Thinking	Feelings, Interrelationships	Outward Behavior
capacity to abstract tolerance for ambiguity intelligence judgment	authority activity achievement sensitivity involvement maturity interdependence articulateness stamina (physical/mental) sense of humor adaptability	vision perseverance personal organization integrity social responsibility

(Levinson, 1980:113-120)

Kerzner

Dr. Harold Kerzner conducted research on the formal education requirements for project managers. He studied the educational aspects of developing project management competencies by surveying 392 Project Management Institute members. With a 48% response rate, the survey asked members to rank, in order of preference, courses important for professional development (Kerzner, 1981:38). Industry response out of 177 possible is listed in Table 4. This list indicates perceived importance of education and training in various attributes of project management.

Four conclusions drawn from the study are:

- industry would prefer students to be trained as generalists rather than specialists, with industry providing the necessary detailed instruction with on-the-job training;
- course work should be constructed to provide emphasis on tools and their application, not theory;
- students should be given case studies that are applicable to their industry and interests; and
- there is no consensus that an advanced degree is necessary in order to become an effective project manager (Kerzner, 1981:44).

Table 4. Course Selection Rankings.

Course	Number Identified
Fundamentals of Project Management	160
Planning and Control	142
Accounting and Finance	139
Organizational Behavior	122
Systems Management	121
Law	109
Information Systems	109
Management Policy	105
PERT/CPM	97
Computers	79
Management Science	75
Managerial Economics	71
Government, Management, Environment	70
Production Management	68
Statistics	55
Marketing	55
Multinational/International Trade	45
Quality Control	39

(Kerzner, 1981:42)

Thornberry and Others

Thornberry surveyed one hundred and ten "successful" project managers from a cross section of eight "high technology" firms in and around Boston Massachusetts to determine the "fundamental skills and abilities necessary for project management success" (Thornberry et al., 1983:73). Several different data collection methods were used. First, the subjects were asked to maintain a time and activity log for two weeks to determine where, how, and with whom the project managers spent their time. Secondly, personal interviews were conducted to discover what skills or abilities differentiated between success and failure. Finally, a personality test measuring sixteen statistically different personality traits was used to determine if there were certain traits common among successful project managers (Thornberry et al., 1983:74). From these three survey

techniques, five core dimensions (Table 5) have been identified as necessary for effective project management performance.

Table 5. Core Dimensions of Project Management.

1. Oral Communications (information sharing, monitoring, evaluating)
2. Influencing Skills (Leadership)
3. Intellectual Capabilities (logical, analytical, non emotional)
4. Handling Stress (time management, defusing conflict, accepting ambiguity)
5. Work Skills (planning, organizing, follow-up, delegation, decision making)

(Thornberry et al., 1983:73-76)

Stuckenbruck

Stuckenbruck attempts to design an education program for project management based on the assertion that these is a body of knowledge, skills, and tools that would be common to the needs of all project managers (Stuckenbruck, 1984:12). He relates project management qualifications over a project type continuum as illustrated in Figure 2.

According to Stuckenbruck, a person can not effectively manage a project without an in-depth knowledge of the technical discipline if the project is type one or two. He further states that at a minimum project managers must be proficient in the three primary functions of manager, leader, and integrator. This requires an "educational or training experience which develops the appropriate skills" (Stuckenbruck, 1984:14). This requires as a minimum an understanding of:

1. The theory, principles, and art of good management.
2. Skills with the various tools and techniques useful in planning, monitoring, and controlling a project.
3. Communication skills both oral and written.
4. Leadership skills such as team building and the motivation of team members.
5. The methods of governmental and industrial acquisition, including marketing, proposal, contracts, and contract negotiations.

6. The methods of performance control, including data management, configuration management, reliability, maintainability, and integrated logistics support.
7. The ability to visualize, plan, implement, and control a project from a systems perspective (Stuckenbruck, 1984:14).

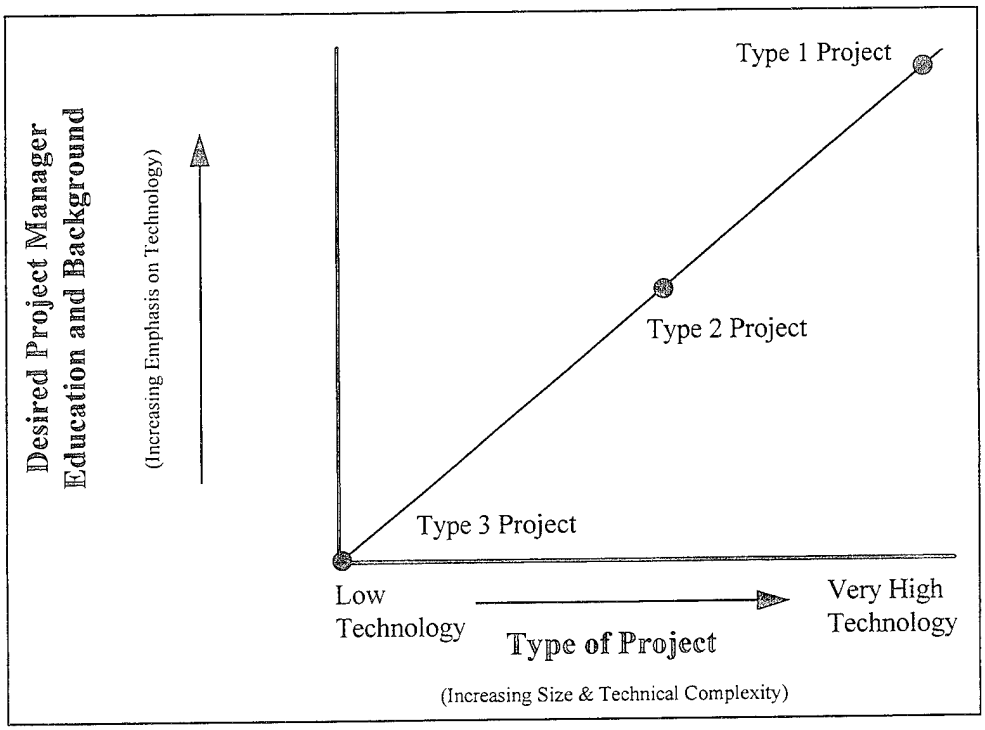

Figure 2. The Relationship of Desired Project Manager Qualification to type of Project (Stuckenbruck, 1984:12).

Thamhain and Wilemon

In a field study conducted by Thamhain and Wilemon, data was collected over a period of three years from a sample of over 400 project leaders. The survey was distributed to "experienced project leaders with a minimum of two years experience in managing multi-disciplinary projects, leading a minimum of three other project professionals, and being formally accountable for the final results" (Thamhain and

Wilemon, 1986:76). The study investigated the practices of project managers regarding their project control experiences. The results of the study include identification of potential problems leading to schedule slips and budget overruns. The number one item was difficulty of defining work in sufficient detail. Lessons learned from the study provided criteria important for controlling projects according to plan. The top ten criteria include:

1. ***Detailed Project Planning.*** Develop a detailed project plan, involving all key personnel, defining the specific work to be performed, the timing, the resources, and the responsibilities.
2. ***Break the overall program into phases and subsystems.*** Use Work Breakdown Structure (WBS) as a planning tool.
3. ***Results and Deliverables.*** Define the program objectives and requirements in terms of specifications, schedule, resources and deliverable items for the total program and its subsystems.
4. ***Measurable Milestones.*** Define measurable milestones and checkpoints throughout the program. Measurability can be enhanced by defining specific results, deliverables, technical performance measures against schedule and budget.
5. ***Commitment.*** Obtain commitment from all key personnel regarding the program plan, its measures and results. This commitment can be enhanced and maintained by involving the team members early in the project planning, including the definition of results, measurable milestones, schedules and budgets.
6. ***Intra-Program Involvement.*** Assure that the interfacing project teams, such as engineering and manufacturing, work together, not only during the task transfer, but during the total life of the project.
7. ***Project Tracking.*** Define and implement a proper project tracking system which captures and processes project performance data conveniently summarized for reviews and management actions.
8. ***Measurability.*** Assure accurate measurements of project performance data, especially technical progress against schedule and budget.
9. ***Regular Reviews.*** Projects should be reviewed regularly, both on a work package (subsystem) level and total project level.
10. ***Signing-On.*** The process of "signing-on" project personnel during the initial phases of the project or each task seem to be very important to proper understanding of the project objectives, the specific tasks, and personal commitment. (Thamhain and Wilemon, 1986).

Project Management Institute (PMI)

The August 1986 Special Issue of the Project Management Journal presents a detailed report on the development of the first Project Management Body Of Knowledge (PMBOK), under the direction of R. Max Wideman. The Project Management Institute

(PMI), an international professional organization for project managers, revised this PMBOK and the PMI Board of Directors approved the final version effective 1 September 1987 (Wideman, 1987). This document has been the basis for the development of education, training, and certification programs since that time. Table 6 identifies the top level function of this baseline concept.

Table 6. Project Management Functions.

Human Resources Management
Cost Management
Time Management
Communications Management
Scope Management
Quality Management

(Wideman, 1987:2-1)

The "Time Management" function was initially broken down into four sub-functions and further subdivided as shown in Figure 3.

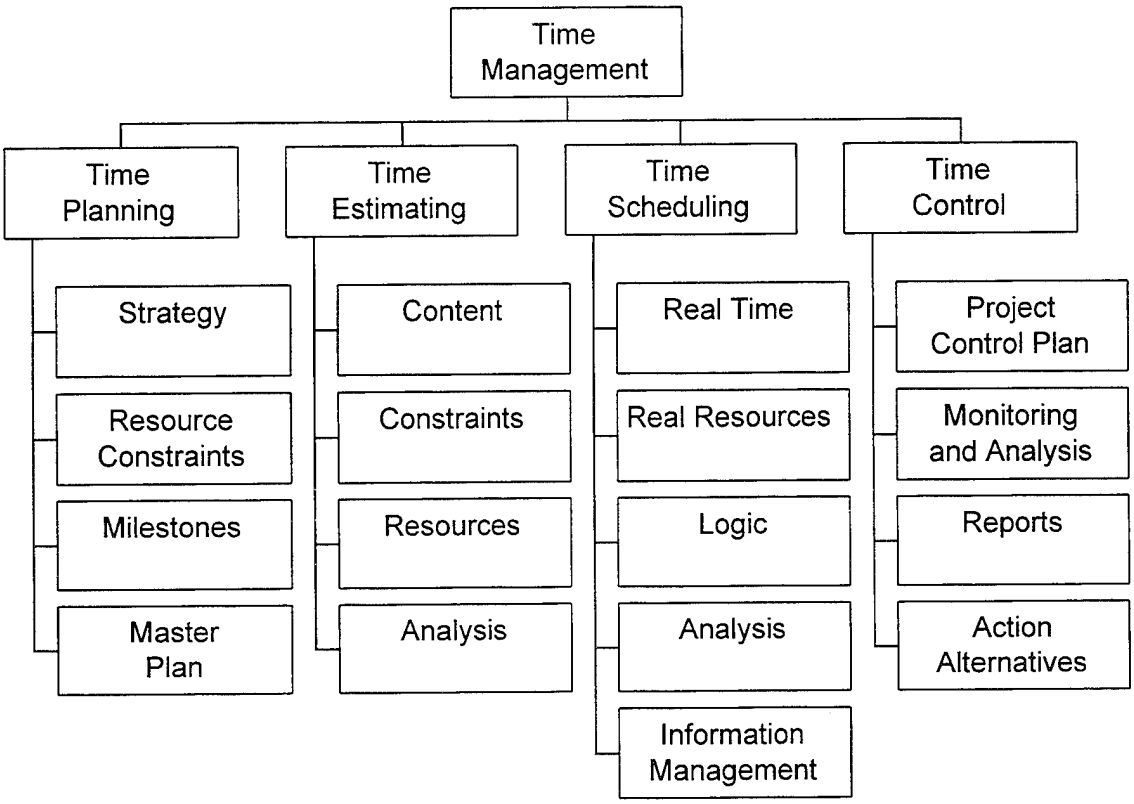

Figure 3. Time Management Functions (Beck, 1987:C3-4).

Table 7 shows the relationship between other project management functions.

Table 7. Function Impact Matrix.

	Time Planning	Time Estimating	Time Scheduling	Schedule Control
a) General Project Management Processes				
Strategic Planning and Control	X			X
Project Integration		X		
Resource Allocation	X	X	X	
b) Basic Project Management Functions or Elements				
SCOPE	X	X		X
COST			X	
TIME				
QUALITY	X	X		
c) Integrative Project Management Functions				
HUMAN RESOURCES	X	X	X	
COMMUNICATIONS	X		X	X
CONTRACT/ PROCUREMENT	X		X	
D) Potential PMBOK Functions				
Probability and Risk		X	X	

(Beck, 1986)

Posner

Selecting a good project manager is not a simple task. "The complex nature and multifaceted range of activities involved in managing projects precludes easily identifying managerial talent and continually stretches the capabilities of talented project managers" (Posner, 1987:51). Two seemingly contradictory viewpoints about what is required to be a good project manager have been advocated. The first prescribes a set of

"personal characteristics" such as aggressiveness, confidence, poise, decisiveness, resolution, entrepreneurship, toughness, integrity, versatility, multidisciplinary, and quick thinking. The other maintains that it would take an extraordinary individual to have all of these critical personal characteristics. Instead, a more practical solution is to identify the "critical problems" faced by project managers and to select an individual who can handle such difficulties (Posner, 1987:51). Posner examined nearly 900 statements about project management problems and nearly 1400 statements about what project management skills make a difference in successfully managing projects. These statements were from 287 respondents to two open-ended questions:

> 1. What factors or variables are *most* likely to cause you problems in managing a project?
>
> 2. What *personal* characteristics, traits, or skills make for "above average" project managers? What specific behaviors, techniques, or strategies do "above average" project managers use (or use better than their peers)? (Posner, 1987:51).

Posner categorized the responses to both questions as shown in Table 8 below.

Table 8. Project Management Problems and Skills.

Project Management Problems
1. Resources inadequate (69%)
2. Meeting (unrealistic) deadlines (67%)
3. Unclear goals/direction (63%)
4. Team members uncommitted (59%)
5. Insufficient planning (56%)
6. Breakdowns in communications (54%)
7. Changes in goals and resources (42%)
8. Conflicts between departments (35%)

(Posner, 1987:51)

Project Management Skills
1. Communication (84%) • listening, persuading
2. Organizational (75%) • planning, goal-setting, analyzing
3. Team building (72%) • empathy, motivation, esprit de corps
4. Leadership (68%) • set example, energetic, vision, delegates, positive
5. Coping (59%) • flexibility, creativity, patience, persistence
6. Technological (46%) • experience, project knowledge

(Posner, 1987:53)

The results of Posner's study suggest that the two perspectives are not contradictory but are fundamentally compatible. When the set of required skills is considered side-by-side with the set of critical problems that project managers face, the complementary nature of these two perspectives is evident as illustrated in Table 9 below (Posner, 1987:53).

Table 9. Relationship Between Project Management Problems and Skills.

SKILLS ⇔ PROBLEMS	
Interconnected in Project Management	
Communication	Breakdowns in communications
Organizational	Insufficient planning
	Resources inadequate
Team building	Team members uncommitted
	Weak inter-unit integration
Leadership	Unclear goals/direction
	Interpersonal conflicts
Coping	Handling changes
Technological	Meeting (unrealistic) deadlines

(Posner, 1987:53)

Pettersen

Pettersen derived, from an extensive literature review of over 60 publications, an integrated requirements profile for selecting project managers (Pettersen, 1991:21). This set of predictors is listed in Table 10.

This list is not exhaustive; only those which can be applied to a wide range of project management positions were included. However, this integrated requirements profile is based on an extensive literature review and a model of performance at work which can be represented by the following formula (Pettersen, 1991:22):

PERFORMANCE = ABILITIES x MOTIVATION x PERSONALITY

Table 10. List of Predictors for Project Managers.

A. Problem Solving
1. Problem analysis
2. Judgment and practical sense
3. Decisiveness
B. Administration
4. Planning and organization
5. Control
6. Strategy and organizational know-how
7. Specialized knowledge
C. Supervision and Project Team Management
8. Delegation of responsibilities
9. Team structuring
10. Consideration towards team members
11. Development of team members
12. Teamwork, flexibility and cooperation
13. Resolving conflicts
D. Interpersonal Relations
14. Oral communications
15. Interpersonal influence, persuasion and negotiation
16. Ascendancy
E. Other Personal Qualities
17. Need to achieve and proactivity
18. Self-confidence, maturity and emotional stability
19. Loyalty, honesty and integrity
20. Tolerance towards ambiguity and openness to change
21. Interest in the job

(Pettersen, 1991:22-24)

Thamhain

Thamhain researched the "approaches to project management training and development" (Thamhain, 1991:39). Data was collected through interviews and survey of 220 project managers and examination of actual training and development records. As supported in the literature, project management requires skills in three primary areas:

1. leadership/interpersonal;
2. technical;
3. administrative.

Table 11. Skill Development Methods and Their Effectiveness.

Training & Development Method (1)	Effectiveness Of: Leadership	Technical (2)	Administrative	Professional Participation: % (3)	# (4)	Avg
1. Experiential learning	H	H	H	100	64	64
2. Observations of management practice	S	L	S	100	10	10
3. Formal on-the-job training	S	H	H	8	117	9
4. Literature reading	L	S	L	50	16	8
5. Coaching by upper management	S	L	L	15	16	1.6
6. Seminars and workshops	S	S	S	33	4.6	1.5
7. Formal courses (degree programs)	S	S	S	11	9	1
8. Consulting	S	H	H	8	12	1
9. Professional conferences	L	S	S	27	2.5	0.7
10. Special work groups	S	H	H	21	2	0.5
11. Formal courses (continuing education)	L	S	S	6	5	0.3
12. Job rotation	S	S	S	7	?	?

Skill Development Days — PMgrs Days/Mgr/Yr

Legend:
(1) Training and development method: as defined by project managers.
(2) Skill development: primary skill areas developed as perceived by project managers.
Effectiveness level code:
H - highly effective method S - somewhat effective method L - low-effective method
(3) Percent participation: percentage of project leaders participating in method (1) out of all project managers in company.
(4) Number of days: the number of work days per year spent by those project managers who participate (3) in method (1).

(Thamhain, 1991:42)

Thamhain asked project managers to indicate the methods most desirable for developing overall competence in project management. The project managers were then asked to indicate the relative contribution of different training methods towards their professional development (Thamhain, 1991:41). Table 11 lists the twelve most popular methods of project management skill development used in industry and government organizations. The list is rank-ordered by intensity of use and effectiveness.

Kanungo and Misra

Kanungo and Misra provide a framework for distinguishing between "skills" and "competencies" along several dimensions such as specific – generic, task driven – person driven, and transferable – non-transferable conceptualizations. Integrating research from various fields of cognitive, clinical, personality, and social psychology, Kanungo and Misra identify various components of resourcefulness which have implications for selection and training of managers.

Kanungo and Misra argue that competencies refer to the mental capabilities that lead to successful adaptation to the real-world context, especially for non-routine tasks in a volatile environment. These capabilities are the inner resources that managers possess. Skills on the other hand, are needed for tasks that are routine or programmed in a stable environment. Competencies are generic in nature, whereas skills are specific to the task. Without accompanying competencies, these technical and routine task related skills will remain dormant (Kanungo and Misra, 1992:1322).

Kanungo and Misra provide a set of three general categories of competencies as detailed in Table 12. Their model has not been validated by research but is based on a review and critique of relevant literature. Possession of these competencies has been conceptualized as managerial resourcefulness.

Table 12. Components of Managerial Resourcefulness.

1. Affective Competence
a. controlling primitive terminal reactions in situations that produces strong emotions
b. developing equanimity and problem orientation
c. delay of gratification
d. high proactive involvement, enthusiasm, interest, and commitment to meeting challenges in life
2. Intellectual Competence
a. intellectual competence to solve problems
b. self-reflection for strengthening self-efficacy belief
3. Action-oriented Competence
a. task-related action orientation with regard to goal and plan development and use of feedback
b. people-related action orientation

(Kanungo and Misra, 1992:1325)

Bubshait and Selen

Using field data from forty-two projects conducted in the U.S., Bubshait and Selen developed a relationship between the number of project management techniques used and selected project characteristics. A statistically significant model was derived indicating the importance of project characteristics such as project type, complexity, and resource limitations, as well as some important interaction effects among characteristics (Bubshait and Selen, 1992, 46).

The project characteristics and project management techniques used in this study are listed in Table 13 and 14. The sample data consisted of projects that could be expected to draw upon project management techniques as described in Table 13. Forty-eight projects were selected to represent different industrial sectors with forty-two usable responses obtained.

Those surveyed responded to the following two-part question:

> How much managerial/administrative complexity (not technical complexity) was involved in the project with respect to:
>
> a) the number of organizational units involved;
>
> b) the amount of communication and coordination required due to interdependencies.

Table 13. Project Characteristics.

1. Project duration	6. Contractual deadline
2. Project type	7. Number of employees directly involved
3. Project total cost	8. Managerial project complexity
4. Number of activities	
5. Resource limitation	

(Bubshait and Misra, 1992:43)

Table 14. Examined Project Management Techniques.

1. Planning/Scheduling Techniques	2. Control Techniques
a. Work breakdown structure	a. Progress measures
b. Gantt (bar) charts	(1) percent complete
c. Milestones	(2) estimate to complete
d. Project networks	(3) remaining duration
(1) activities-on-arrows	b. PERT/COST
(2) activities-on-nodes	c. Structuring of costs
(3) precedence diagrams	(1) by type of work
e. Critical path method (CPM)	(2) by resource type
f. PERT statistical approach	(3) by contract
g. GERT/simulation	d. Trend analysis
h. time/cost tradeoff analysis	e. Earned value
i. Resource leveling/allocation	f. Regular meetings and status reports
j. Computer applications	
k. Linear responsibility chart	

(Bubshait and Misra, 1992:43)

The answers were scaled from "simple" - to - "relatively simple" - to - " relatively complex" - to - "complex." Other classification questions determined the number of

project activities, project duration, actual cost, number of employees, availability of resources, and whether or not the project has a contractual deadline.

The results indicate a positive relationship between the number of project management techniques used and the complexity involved in the project (Bubshait and Selen, 1992, 45). In general, the model highlights the importance of three main project characteristics: project type, complexity, and resource limitation.

Government Research

Government researchers have conducted studies and analyses in various program management related areas. The more relevant studies are presented here in chronological order.

Smythe and McMullan

Smythe and McMullan examined the education and experience backgrounds desired of Air Force System Program Directors. The objective of the research was to identify and compare major qualifications desired of project managers during various phases of the system acquisition process (Smythe and McMullan, 1975:41). The "conceptual" and "validation" phases were combined into the "young" classification category. The "full scale development" phase became the "mature" category and the "production and deployment" phases were combined to become the "old" category.

Data was obtained concerning the educational and experience backgrounds desired at each of the three "stages" or categories of the acquisition life cycle through personal interviews with twenty-four Program Directors of major Air Force weapon

system acquisition programs. Each Program Director ranked both the education and the experience backgrounds in order of perceived importance separately for each stage of the acquisition life cycle.

The study indicates that those individuals most desired for project management positions have the kinds of common educational and experience backgrounds that foster similar decision making behavior. Additionally, the specific common education and experience background most desired for a particular project probably depends on the acquisition phase in which the project is currently experiencing. Early on, the ability to relate to technical aspects appears to be most appropriately provided by individuals with engineering backgrounds. Later, as the project shifts to problems of integration, scheduling, and cost control, managerial knowledge and experience appear to become relatively more important.

Gadeken

Dr. Owen Gadeken, Director of Educational Research at Defense Systems Management College (DSMC), conducted a study which identified characteristics distinguishing DoD's best acquisition program managers. The study examined competencies based on 56 in-depth interviews of Army, Navy, and Air Force program managers (Gadeken, 1989a:42).

The preliminary model was validated through a follow-on survey questionnaire distributed to over 500 acquisition professionals. Gadeken's model is at table 15.

Table 15. Program Manager Competency Model.

(Numbers below do not indicate order of importance)

Managing the External Environment

* 1. Sense of ownership/mission
* 2. Political awareness
* 3. Relationship development
* 4. Strategic influence
* 5. Interpersonal assessment
6. Assertiveness

Managing the Internal Environment

7. Managerial orientation
8. Results orientation
9. Critical inquiry

Managing for Enhanced Performance

10. Long-term perspective
11. Focus on excellence
12. Inovativeness/initiative
13. Optimizing
14. Systematic thinking

Proactivity

* 15. Action oriented
16. Proactive information gathering

* Denotes competencies which distinguish outstanding from effective program managers (at p = .03) .

(Gadeken et al, 1989:27)

The results of the study indicate:

1. Sixteen competencies were identified from program manager interviews and confirmed by follow-on survey;
2. Six of these competencies, based on frequency, most differentiated outstanding from effective program managers;
3. Acquisition professionals identified and prioritized a different set of competencies than program managers;
4. Minimal differences exist in the 16 competencies across the Services, program phase or program size;
5. Program managers and acquisition professionals emphasized the importance of acquisition policy and management knowledge areas; and
6. Program managers and acquisition professionals reported a need for training in software and several business functions (Gadeken, 1989b:24).

Gadeken and Cromwell

As part of its ongoing program of educational research, the DSMC initiated a survey to determine how program management training and development was accomplished by major defense contractors. Gadeken and Cromwell surveyed 32 companies/divisions with a set of standard questions with interview questions providing additional data (Gadeken and Cromwell, 1991:23). The results are at Table 16.

Table 16. Summary Results of Defense Industry Survey.

	YES	NO
1. Is there a distinctly recognizable group of program managers in your company/division?	7	25
2. Is there a formal process for selecting program managers and what are the criteria for selection?	4	28
3. Does your company have written policies covering the development of program managers?	2	30
4. Are there required courses or development tracks for program managers?	2	30
5. In your company, are there courses or programs available only to program managers?	23	9

6. What is the content and duration of these courses?	# courses	Avg. Length
Orientation course for new PM's	8	5 days
Overview course for existing PM's	18	5 days
Advanced course for experienced PM's	3	3 days
(23 companies offer 29 courses)	29	

Major Topic Areas	Number of courses which included it (% of 29 total)
Company/DoD acquisition environment	13 (45%)
Technical management	10 (34%)
Business management	15 (52%)
Project management	18 (62%)
Leadership/management skills	16 (55%)

7. How were these courses developed?

	Internal staff (only)	Internal staff and consultants	Consultants (only)
Developed by (29 total)	16	9	4
Taught by (29 total)	17	10	2

8. In your company/division, who has the responsibility for program manager training and development?

Line management	5
Designated director of program management training	2
Within corporate or division training function	25

(Gadeken and Cromwell, 1991:24-25)

This study highlighted the fact that program management in DoD and the defense industry is dynamic. "Training programs which were relevant and sufficient a few years ago are now being questioned and redesigned, discontinued entirely, or replaced by programs based on new philosophies of program management. Study results should be

interpreted as a snapshot of the current climate, thinking, and approaches to the emerging discipline of program management development" (Gadeken and Cromwell, 1991:26).

Best and Kobylarz

The earlier work of the Project Management Institute was extended to the DoD by Best and Kobylarz in an effort to develop a Defense Body of Knowledge (DBOK) for DoD acquisition program management. The DBOK was compiled from all the knowledge areas that a program manager must know and understand to be effective (Best and Kobylarz, 1991:ii). Through their research, they developed a model composed of thirteen major areas, each with numerous sub-areas. Table 17 shows the priority ranking of these thirteen major areas. Cost management is third in priority after leadership / personal skills and strategy planning. Low xbar (mean rank) equals a high priority.

Table 17. Major Area Priority

Major Area	Priority (xbar)	Standard Deviation
Strategy and Planning	3.74	2.71
Quality Management	7.72	3.34
Cost Management	5	2.65
Risk Management	5.53	3.02
Leadership/Personal Skills	2.89	2.94
Management Techniques	5.89	3.29
Systems Engineering	6.81	2.79
Test and Evaluation Management	9.08	2.31
Logistics Management	9.36	2.13
Manufacturing Management	10.85	2.42
Contract Management	6.92	2.57
Software Management	10.13	2.87
Aerospace and Defense Management	5.62	3.96

(Best and Kobylarz, 1991:46)

Table 18 shows the results of the cost management sub-areas. Survey respondents chose cost/schedule control as second in importance after planning, programming & budgeting system. Cost/schedule control and estimating are but two of the many sub-areas directly applicable to time (schedule) management.

Table 18. Results of Cost Management Prioritization

Subarea	Importance (xbar)	Standard Deviation
Estimating	1.23	0.70
Life Cycle Cost Analysis	1.19	0.65
Design to Cost	0.66	0.71
Planning, Programming & Budgeting System	1.68	0.61
Reprogramming	0.91	0.66
Cost/Schedule Control	1.64	0.52
Contractor Financial Management	1.26	0.62
Financial Analysis of DoD Contractors	0.62	0.60
Project Accounting	0.70	0.64
Capital Investment	0.36	0.48
Should Cost/Could Cost Analysis	0.81	0.59

(Best and Kobylarz, 1991:52)

Acquisition Management Functional Board

The Acquisition Management Functional Board (AMFB) is a joint service board with members from the Army, Navy, and Air Force as well as from the DSMC. Its goal was to "obtain a practical set of competencies for the [acquisition management] career field" (AMFB, 1993:1). The board identified competencies requiring formal education. The model grouped a total of 129 competencies into the twelve areas shown in Table 19.

Table 19. AMFB Program Management Model.

1. Acquisition Policy	7. Managerial Development
2. Contract Finance	8. Manufacturing Management
3. Contract Management	9. Program Management
4. Cost/schedule Control	10. Software Management
5. Fiscal Management	11. Systems Engineering
6. Logistics Support	12. Test and Evaluation

(AMFB, 1993)

Hazeldean and Topfer

Hazeldean and Topfer conducted an AFIT-sponsored research which focused on pre-contract-award management actions of small-scale, design and development contracts and the relationship of these actions to schedule performance. Three phases of the contractual process were studied: planning the acquisition, specifying the requirements, evaluating the proposals, and monitoring and controlling the resultant contract (Hazeldean and Topfer, 1993:1-7). Each of these four activity areas involves management actions which can potentially affect schedule performance.

Hazeldean and Topfer first identified those actions affecting schedule performance, quantified their effect, and then determined which of these actions can be implemented in a cost effective manner. Data was collected from 25 contracts and compiled on a four page data collection instrument with the following main sections:

1. contract details and project characteristics;
2. planning variables;
3. specifying variables;
4. evaluating variables.

The planning, specifying, and evaluating variables are listed below in Table 20.

Table 20. Data Collection Variables.

Planning Variables	Specifying Variables	Evaluating Variables
1. schedule strategy	1. specification	1. evaluation criteria
2. sources of supply	2. develop WBS further	2. schedule-risk assessment information
3. planned contract type	3. C/SSR required	
4. schedule risk	4. specific schedule-management paragraphs	
5. technical risk	5. frequency of reporting schedule-management information	
6. complexity	6. CDRL/DIDs	
7. work breakdown structure		
8. draft RFP		

(Hazeldean and Topfer, 1993:3-9).

From the analyses conducted, the following factors were found to be significantly related to schedule performance:

1. the contract was pre-scheduled (positively related);
2. the contract involved concurrency (negatively related);
3. a preliminary WBS had been developed (positively related);
4. the contract utilized a Functional Specification or a Prime Item Development Specification (positively related);
5. the contract required the schedule information to be presented in a network format (positively related); and
6. the number of DIDs required by CDRL (positively related); (Hazeldean and Topfer, 1993:5-6,7).

Additionally, just as important perhaps is that the following factors were found to be not significantly related to schedule performance:

1. the contract type,
2. the aggressiveness of the schedule,
3. the assessment of technical risk,
4. the development of the WBS,
5. the requirement for C/SSR,
6. the frequency of reporting schedule-management information,
7. the number of project management DIDs,
8. the number of evaluation criteria related to schedule-management, and
9. the evaluation of schedule-management information during source selection (Hazeldean and Topfer, 1993:5-8).

Just as significant is the finding that the management of schedule is not well understood within the SPOs. Hazeldean and Topfer conclude by suggesting the ability to exploit the available schedule-management tools may require special training and education (the topic of this thesis).

Baxter and Bolin

Baxter and Bolin examined the cost-management competencies required of defense program managers. A model was developed and evaluated through a mail survey of 682 intermediate and senior level Air Force program managers in Air Force Materiel Command. The information provided by the 330 respondents indicates that 29 of the 47 cost-management competencies in the model were valuable to the program managers. The survey data also indicates that program managers rely more on understanding the concepts than on actually being able to complete the tasks themselves (Baxter and Bolin, 1994:90).

Baxter and Bolin derived their model primarily from the cost-management portions of the PMBOK and AMFB models. Their derived model has three major sections: cost estimating & forecasting, cost budgeting, and cost controls. Of these three, their relative importance, as indicated by the program manager's responses, is illustrated in Figure 4 below.

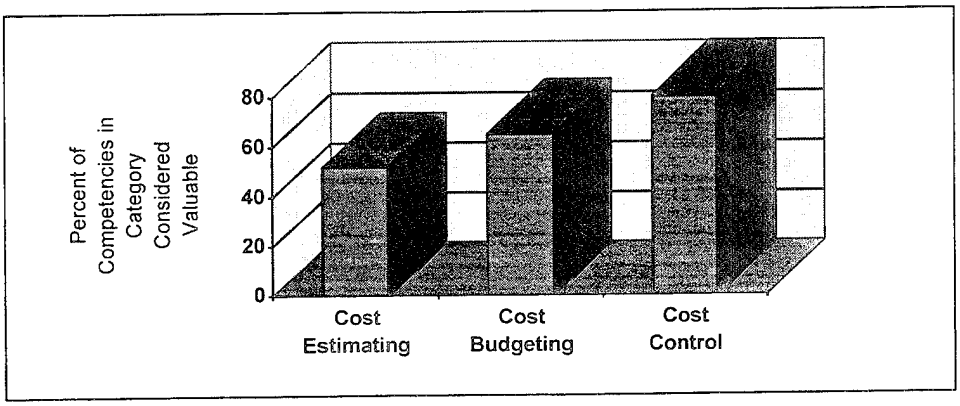

Figure 4. Valuable Competencies by Model Category, (Baxter and Bolin, 1993:72).

The model developed for this study included competencies at both the comprehension and application levels of learning. There are 18 "Be able to" competencies and 29 "Understand" competencies. Figure 5 illustrates the level of learning required for the valuable competencies.

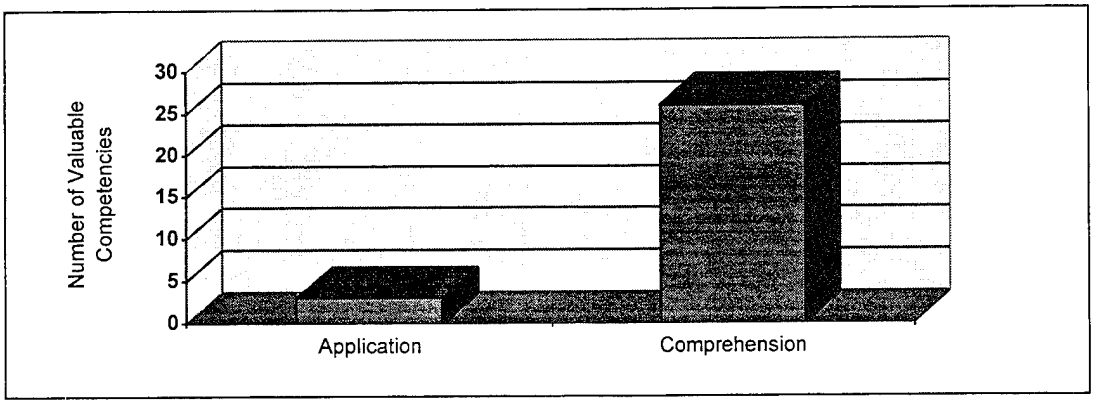

Figure 5. Level of Learning Required for Valuable Competencies, (Baxter and Bolin, 1993:73).

Figure 5 clearly shows that more of the comprehension competencies were found to be valuable. The analysis indicated that 90% of the comprehension competencies were valuable while only 17% of the application competencies were considered valuable.

Summary

The various studies and models presented here show the diversity of methods used to present the competencies required of program managers. Approaches have varied from the consideration of general personality traits and skills to identification of specific knowledge and ability requirements. A significant portion of the research on program management has focused on personality-type characteristics, while specialized areas like schedule-management have received limited attention. Specifically, the area of schedule-management is addressed only slightly by Mueller, Baker and Wilemon, and Kerzner

with the PMBOK, Bubshait and Selen, Best and Kobylarz, the AMFB, and Hazeldean and Topfer revealing the most emphasis on schedule-management competencies in this literature review.

The subjective personality-type competencies like leadership and communication which comprise the majority of this literature are certainly relevant to characterizing general traits of successful program managers, but they do little towards identifying competencies in specific program management areas (like schedule-management) in sufficient detail to develop education and training programs.

Of the schedule-management literature reviewed, the PMBOK and AMFB models provide the greatest level of detail. However, these models do not identify the perceived value of each schedule-management competency or any variance among subgroups of the population of interest, Air Force program managers. Without this, the research accomplished to date is of limited use in optimizing education and training. A model identifying which individual competencies program managers actually value in their day to-day activities would provide this type of information. The model developed in chapter 3 of this thesis was designed to support this purpose.

The method of acquiring schedule-management competencies is not the focus of this research. However, it is a logical question following the identification of the competencies that program managers rely on. Research by Kerzner identified the perceived relative importance of education and training courses in various aspects of project management. Kerzner and Thamhain both emphasized the importance of

acquiring management skills through experience and special programs developed by individual organizations to meet their individual needs. These studies were included in the literature review to begin to bridge the research of *what* competencies are valuable, with future research of *how* the DoD should develop them.

III. Methodology

Overview

The primary purpose of this study was to identify schedule-management competencies valuable to military program managers. An extensive literature review was conducted to compile a list of schedule-management skills necessary for effective management of projects. From this review and past research, a schedule-management competency model was developed. The perceptions of 484 intermediate and senior level military program managers from three Air Force bases within the Air Force Materiel Command were polled through a mail survey. This chapter discusses the development of the model, the approach taken to obtain an adequate sampling of the population, the survey instrument development and test, and the procedures used to analyze the data.

Model Development

Integration of the abundance of material available into a concise model required consideration of the relevance of each candidate competency and the level of indenture necessary to ensure model efficiency. The goal was to develop a broad-based model reflecting the key schedule-management competencies, not to list every tool and technique a program manager might use. This is an important fact to consider when reviewing the survey results since numerous respondents attempted to broaden the scope of the research by introducing many other management and team-building disciplines which are, as the literature review indicated, extremely important for program management, but not specifically germane to the topic at hand. The model was

constructed beginning with the structure, followed by selection of major subject areas and appropriately indentured sub-areas.

Model Structure

The structure of the model was based on the Project Management Body of Knowledge (PMBOK). The function of Time Management has been divided into four categories: planning, estimating, scheduling, and control (see Figure 6 below).

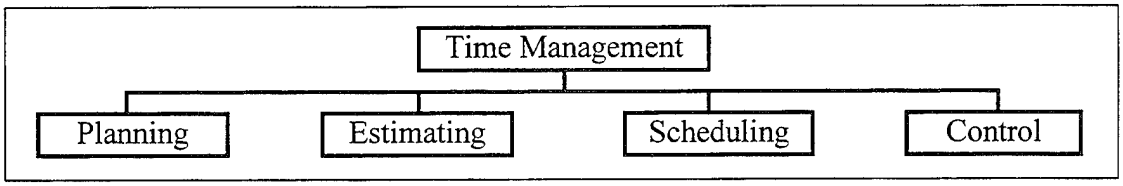

Figure 6. Top-level Time Management Function Chart per PMBOK, (PMI, 1987:C1).

Planning consists of identification of the project goals, how it will be accomplished, and what will be used to do it. Estimating is the determination of the duration of an activity. Despite all the sophistication, however, it is something we can only attempt with a limited degree of accuracy due to the uncertainties associated with imperfect humans and their working conditions. Scheduling is the recognition of realistic time and resource restraints which will, in some way, influence the execution of the plan. Control requires the measurement of what actually happened against what was expected to happen and the implementation of steps to prevent undesirable impacts and the continuation of acceptable results (PMI, 1987:C1).

Project Time Management includes the processes required to ensure timely completion of the project. The Project Time Management structure as revised in the

Exposure Draft 8-94 has been subdivided into five categories (See Figure 7):

1.0 Task Definition - identifying the specific activities that must be performed to produce the various project deliverables;

2.0 Task Sequencing - identifying and documenting inter-task dependencies;

3.0 Duration Estimating - estimating the number of work periods which will be needed to complete individual activities;

4.0 Schedule Development - analyzing task sequences, task durations, and resource requirements to create the project schedule;

5.0 Time Control - maintaining the project schedule (PMI, 1994:24).

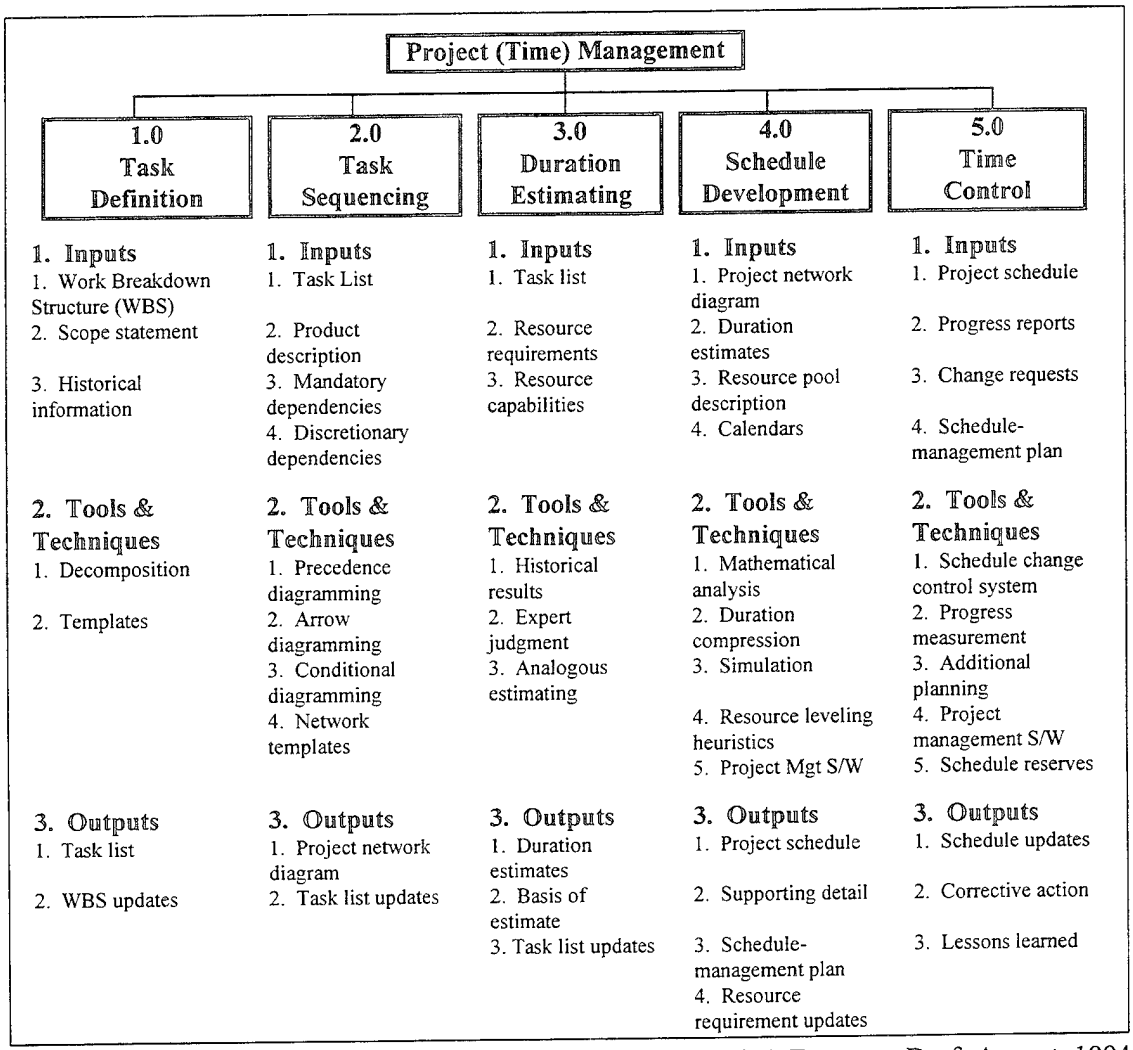

Figure 7. Detailed Project Time Management Chart per PMBOK, Exposure Draft August, 1994.

Even though the processes are presented in this model as discrete elements, in practice, they may overlap and interact in ways not detailed here. While task definition and task sequencing have been previously considered as simply planning, they are presented here as distinct processes because the tools and techniques for each are different. Figure 8 identifies the top-level structure of the model. For purposes of this model, the terms "activity" and "task" are considered functionally equivalent and interchangeable.

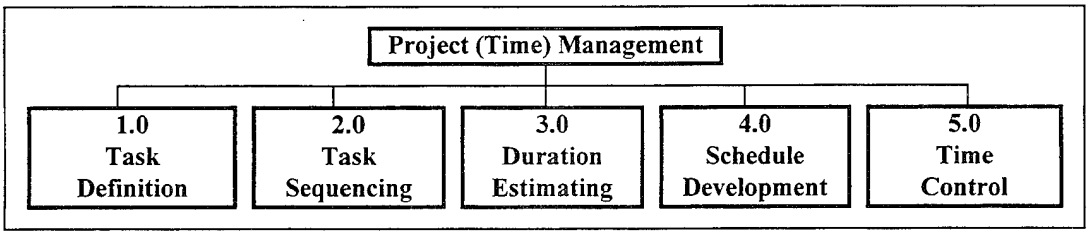

Figure 8. Model Structure.

Model Elements

The competency topics were synthesized from the contents of the PMBOK, its revised draft, the work of the Acquisition Management Functional Board (AMFB), and schedule-management activities discussed in the numerous other documents reviewed. The PMBOK contains a number of schedule (time) management competency areas grouped into the categories listed in Figure 8. The AMFB competency model identified a number of competencies in the schedule-management area and specified a desired level of learning required at each of the three levels of APDP certification (AMFB, 1993). The AMFB categorized these levels of learning using a six stage hierarchical order of learning (see Table 21) developed by Benjamin Bloom (Bloom, 1956).

Table 21. Bloom's Taxonomy of Learning.

Knowledge
Comprehension
Application
Analysis
Synthesis
Evaluation

(Bloom, 1956:18)

The initial model devised from the revision to the PMBOK was very detailed. This model (see Table 22) listed 145 separate skills in the five categories. Research at this level would require a separate study of each category. A more concise and efficient model required considerable work to distill the more pertinent skills reflecting the key schedule-management competencies. Additionally, the model must consider the level of learning required, focusing on whether the skill must be *understood* or actually *performed*. These two simplistic levels of learning are roughly analogous to Bloom's comprehension and application levels.

In the revision of the initial competency model, the significance and level of indenture of the topic areas was considered in an attempt to balance the need to adequately cover the range of schedule-management topics with the desire for a concise model. Redundant topics were eliminated as were topics not directly associated with schedule-management. The competencies were organized within the structure defined in Figure 8 above. The result of this synthesis is the 28 element model shown in Table 23. The survey questionnaire was written from this final model with 56 questions focusing on the program manager's ability to both *understand* and *perform* particular tasks.

Table 22. PMBOK Schedule-management Competency Model.

1.0 TASK DEFINITION

Task definition involves specifying the activities to be performed in order to provide the deliverables called out in the project's statement of work and designated in the work breakdown structure. Implicit in this process is the need to define the activities such that the project objectives will be met.

1.1 Inputs to Task Definition

1.1.1 Understand the key cost/schedule related elements to be considered when developing a request for proposal.
1.1.2 Understand the cost/schedule implementation and review process.
1.1.3 Be able to define the scope, objectives, constraints, and tasks of the project.
1.1.4 Understand the construction of the work breakdown structure (WBS) and its relationship to cost and schedule tracking and reporting.
1.1.5 Able to develop a WBS describing the project work effort.
1.1.6 Understand how to use the WBS for time management.
1.1.7 Know where to find the project scope and objectives.
1.1.8 Know what activities were required on previous, similar projects.
1.1.9 Able to relate previous project activities to the current project.

1.2 Tools & Techniques for Task Definition

1.2.1 Understand the methods of task decomposition.
1.2.2 Able to break down tasks to component-level activities.
1.2.3 Can relate current project elements to similar elements of a previous project.
1.2.4 Able to use similar WBS elements as a template for task definition.

1.3 Outputs from Task Definition

1.3.1 Able to develop task lists identifying all activities to be performed on the project.
1.3.2 Able to organize the task lists as an extension to the WBS to ensure completeness.
1.3.3 Able to interpret the task lists to understand how the work is to be done.
1.3.4 Able to refine the project WBS as a result of the task definition process.
1.3.5 Understand what to look for in a WBS.
1.3.6 Able to recognize insufficient work definition.

2.0 TASK SEQUENCING

The identified activities must be sequenced accurately in order to support later development of a realistic and achievable schedule.

2.1 Inputs to Task Sequencing

2.1.1 Understand how to interpret a task list.
2.1.2 Able to review the product description to ensure accuracy.
2.1.3 Understand the affect of product characteristics on task sequencing.
2.1.4 Understand the difference between mandatory and discretionary dependencies.
2.1.5 Able to differentiate mandatory and discretionary dependencies.
2.1.6 Understand the difference between internal and external dependencies.
2.1.7 Able to identify external interfaces with other projects.
2.1.8 Understand the terms "lead" and "lag."
2.1.9 Able to define lead and lag relationships between tasks.

2.2 Tools & Techniques for Task Sequencing

2.2.1 Able to determine sequence and lead time of resources to meet required delivery dates.
2.2.2 Understand the methods for allocating scarce manpower resources over the period of the project.
2.2.3 Familiar with Precedence Diagramming Method and Arrow Diagramming Method.
2.2.4 Able to construct a project network diagram representing activities and their dependencies.
2.2.5 Able to apply the PDM or ADM techniques to construct a project network diagram.
2.2.6 Understand when the conditional diagramming methods are required.
2.2.7 Able to construct network diagrams with non-sequential activities.
2.2.8 Understand the benefits of using network templates.

2.3 Outputs from Task Sequencing

2.3.1 Able to follow a project network diagram.
2.3.2 Understand the logical relationships (dependencies) of project activities
2.3.3 Able to update task lists based on sequencing.
2.3.4 Able to follow the logic in the sequencing of tasks.

3.0 DURATION ESTIMATING

Duration estimating is assessing the number of work periods likely to be needed to complete each identified task. The person or group on the project team who is most familiar with the nature of a specific task should make (or at least approve) the duration estimate.

3.1 Inputs to Duration Estimating

3.1.1 Able to identifying activities within task lists.
3.1.2 Understand the project resource requirements.
3.1.3 Understand the personnel resource capabilities.

3.2 Tools & Techniques for Duration Estimating

3.2.1 Know where to find information on the likely durations of many categories of activities.
3.2.2 Know how to obtain records of previous project results.
3.2.3 Understand how to use previous project results to aid in developing duration estimates.
3.2.4 Able to obtain previous actuals or estimates from project team members.
3.2.5 Understand the use of expert judgment guided by historical results.
3.2.6 Able to estimate duration of tasks based on duration of similar activities.
3.2.7 Able to use statistical analysis methods such as range analysis and confidence intervals to characterize uncertainty associated with task duration estimates.
3.2.8 Understand the implications of uncertainty associate with task duration estimates.
3.2.9 Understand methods to minimize resource requirements.
3.2.10 Understand time compression techniques such as removing non-value-adding activities off the critical path to reduce unnecessary delays.

3.3 Outputs from Duration Estimating

3.3.1 Able to estimate duration.
3.3.2 Understand how to report the likely number of work periods required to complete a task.
3.3.3 Understand the need to indicate the range of possible results in the estimates.
3.3.4 Understand the assumptions made in developing the estimates.
3.3.5 Able to split tasks into two or more in order to provide a more accurate estimate.

4.0 SCHEDULE DEVELOPMENT

Schedule development means determining start and finish dates for project activities. If the start and finish dates are not realistic, the project is high risk. The schedule development process must often be iterated (along with the processes that provide inputs, especially duration estimating and cost estimating) prior to determination of the project schedule.

4.1 Inputs to Schedule Development

4.1.1 Able to follow a project network diagram.
4.1.2 Able to interpret duration estimates.
4.1.3 Know the availability of project resources (people, equipment, material).
4.1.4 Able to use project and resource calendars to identify periods when work is allowed.
4.1.5 Understand the difference between project calendars and resource calendars.
4.1.6 Able to recognize project constraints and their influence on schedule development.
4.1.7 Understand how to schedule tasks with imposed dates.
4.1.8 Understand how to schedule distinct, measurable, identifiable milestones.
4.1.9 Able to specify resource or duration assumptions.

4.2 Tools & Techniques for Schedule Development

4.2.1 Able to conduct mathematical analysis to calculate theoretical early and late start and finish dates.
4.2.2 Understand the Critical Path Method (CPM) procedure for float and scheduling flexibility.
4.2.3 Understand the Graphical Evaluation and Review Technique (GERT) process.
4.2.4 Able to calculate probabilities for both network logic and duration estimates.
4.2.5 Understand the use of Program Evaluation and Review Technique (PERT) method.
4.2.6 Able to use network logic and a weighted average duration estimate to calculate project duration.
4.2.7 Understand the differences between CPM, GERT, and PERT.
4.2.8 Understand the concept of duration compression techniques.
4.2.9 Able to look for ways to shorten the project schedule without changing the project scope.
4.2.10 Able to use crashing technique to conduct cost and schedule trade-offs.
4.2.11 Understand the use of fast-tracking to schedule activities in parallel.
4.2.12 Able to perform simulation to calculate multiple schedules with different sets of assumptions.
4.2.13 Understand how Monte Carlo simulation is used to calculate a distribution of probable results.
4.2.14 Understand resource leveling heuristics.
4.2.15 Able to use heuristics to develop a schedule that reflects necessary constraints
4.2.16 Understand the use of project management software.
4.2.17 Able to develop project schedule with project management software.
4.2.18 Able to use statistical analysis methods to characterize uncertainty associated with schedule estimates.
4.2.19 Understand the implications of uncertainty associate with schedule estimates.
4.2.20 Understand the effects of activity time variance on critical path planning.

4.3 Outputs from Schedule Development

4.3.1 Able to develop the project schedule.
4.3.2 Understand how to interpret the project schedule.
4.3.3 Able to prepare a project schedule from network diagrams with date information added.
4.3.4 Understand the usage of the following: network, milestone, lead-time and line of balance charts.
4.3.5 Understand the construction of Gantt charts.
4.3.6 Able to incorporate capacity into resource scheduling.
4.3.7 Able to show task start and end dates as well as expected durations.
4.3.8 Able to use milestone charts to identify the scheduled start or completion of events.
4.3.9 Understand the use of time-scaled network diagrams to show both project logic and task durations.
4.3.10 Understand the use of project supporting detail.
4.3.11 Able to report resource histograms, cash flow projections, or order and delivery schedules.
4.3.12 Understand the use of a schedule-management plan.
4.3.13 Able to define how changes to the schedule will be managed
4.3.14 Understand the effects of resource leveling and task list updates on preliminary estimates.
4.3.15 Understand the products of schedule-management software tools.
4.3.16 Able to develop, analyze, and update schedule baselines.

5.0 TIME CONTROL

Time control is concerned with (a) influencing the factors which create schedule changes, (b) determining that the schedule has changed, and (c) managing the actual changes when and as they occur.

5.1 Inputs to Time Control

5.1.1 Able to interpret the approved project schedule.
5.1.2 Understand what defines the schedule baseline.
5.1.3 Understand what provides the basis for measuring and reporting schedule performance.
5.1.4 Able to use progress reports to obtain information on schedule performance.
5.1.5 Understand how progress reports can be used to identify issues which may cause future problems.
5.1.6 Understand the use of change requests..
5.1.7 Able to use a schedule-management plan.

5.2 Tools & Techniques for Time Control

5.2.1 Understand the use of a schedule change control system.
5.2.2 Able to define the procedures by which the project schedule may be changed.
5.2.3 Understand the paperwork, tracking systems, and approval levels necessary for approving changes.
5.2.4 Understand how to measure progress.
5.2.5 Able to use progress measurement techniques such as earned value (time value of money).
5.2.6 Understand how earned value is used to assess the magnitude of schedule variations.
5.2.7 Able to estimate earned value using methods such as weighted milestones and percent complete.
5.2.8 Understand the concept of variance analysis.
5.2.9 Able to determine if the schedule variation requires corrective action.
5.2.10 Able to revise duration estimates, modify task sequences, or analyze alternative schedules.
5.2.11 Understand how to forecast the effects of schedule changes.
5.2.12 Able to use project management software to track planned dates versus actual dates.
5.2.13 Understand the heuristics of program manager's budget & schedule reserves.
5.2.14 Able to compute schedule variances and determine if planned effort is ahead or behind schedule.
5.2.15 Able to compute schedule performance index to assess schedule efficiency.

5.3 Outputs from Time Control

5.3.1 Able to revise preliminary project schedules.
5.3.2 Understand the use of schedule updates to manage the project.
5.3.3 Understand the impact of schedule updates on other aspects of the overall project plan.
5.3.4 Understand how schedule revisions are used to make changes to the approved project schedule.
5.3.5 Understand how to bring expected future schedule performance into line with the project plan.
5.3.6 Able to expedite tasks through reallocation of resources, contractor incentives, and work arounds.
5.3.7 Able to document lessons learned.
5.3.8 Able to interpret the causes of variances.
5.3.9 Able to document the reasoning behind the corrective action chosen.
5.3.10 Understand the requirements for cost and schedule control systems such as C/SCS.
5.3.11 Able to apply guidelines specified in C/SCSC to establish acceptable control systems.
5.3.12 Understand the impact of changes in scope on contract schedule performance.
5.3.13 Able to identify and analyze cost, schedule, and performance progress/difficulties identify problem areas, assess baseline impacts and develop recommendations.
5.3.14 Able to prepare a written analysis of contractor's performance, to include an assessment of performance to date.
5.3.15 Understand the use of the integrated master schedule as the basis for program reviews.
5.3.16 Understand the impact of schedule slippages on project performance and cost objectives.
5.3.17 Understand the use of exit criteria and their relationship to reduction of cost, schedule, and performance risk.

(PMI, 1994:24-29)

Table 23. Schedule-management Competency Model.

1.0 TASK DEFINITION
1. *Define* tasks to be performed to meet the project objectives
2. *Determine* sequence and precedence relationships of project tasks
3. *Develop* a Work Breakdown Structure (WBS) that describes the project work effort
2.0 TASK SEQUENCING
1. *Allocate* scarce resources over the period of the project
2. *Construct* a project network diagram representing tasks and their precedence relationships
3.0 DURATION ESTIMATING
1. *Estimate* duration of tasks
2. *Understand* the implications of uncertainty associated with task duration estimates
3. *Use* Program Evaluation and Review Technique (PERT) to estimate project duration
4. *Use* Critical Path Method (CPM) to reduce the project schedule consistent with budgetary constraints
5. *Use* computer simulation to develop and analyze estimates of project duration
4.0 SCHEDULE DEVELOPMENT
1. *Construct* timetables such as Gantt charts
2. *Schedule* distinct, measurable, identifiable milestones
3. *Use* heuristics to develop a schedule that is achievable given existing constraints
4. *Use* statistical analysis methods to characterize uncertainty associated with schedule estimates
5. *Distribute* the cost of work packages across the project schedule to develop a performance measurement baseline (PMB)
6. *Detect* insufficient schedule for work defined
7. *Use* schedule-management software tools
5.0 TIME CONTROL
1. *Construct* information briefings to relay schedule status
2. *Perform* trades between cost, schedule, and performance
3. *Understand* the impact of changes in scope on schedule performance
4. *Understand* the concept of earned value and methods for calculating it
5. *Compute* schedule variances
6. *Determine* if schedule variation requires corrective action
7. *Compute* schedule performance index to assess schedule efficiency
8. *Develop* corrective actions to counter unfavorable program variances
9. *Interpret* contractor cost reports (such CPR and CSSR)
10. *Understand* the impact of schedule slippages on performance and cost objectives
11. *Understand* the relationship between contract modifications and the PMB

Sampling Approach

An important step in the data collection and analysis procedure was determining the population and appropriate sample group for administering the survey. Careful consideration of both of these groups sets the foundation for developing the survey instruments and proper interpretation of the results.

Population

The schedule-management competencies required of military program managers was the focus of this research. In particular, the study focused on the perceptions of intermediate and senior level program managers assigned to Air Force Materiel Command (AFMC) program management positions. Since AFMC is responsible for the majority of Air Force acquisition programs, this population should be representative of the Air Force in general.

The population was identified using the program management certification level required for these positions. Each program management position is coded with the desired certification level. Intermediate and senior level program managers fill Level II and Level III positions, respectively. The Acquisition Management Resource Development Team at AFMC (AFMC/XRMA) maintains a database that identifies the person filling each program management position in AFMC. A Total of 1143 military personnel assigned to AFMC, holding positions requiring level II and level III acquisition certification (excluding General officers) formed the original population. The names and addresses of this population were provided by AFMC/DPRO.

Sample Group

Since the research involved analysis of subgroups within the population, a large sample size was needed to ensure representative coverage of each demographic category (management education, organization type, acquisition phase, primary program activity, and current grade level). From the AFMC population, a representative sampling was

obtained by focusing on those holding positions at Aeronautical Systems Center (ASC) and Electronic Systems Center (ESC) including Wright-Patterson, Eglin, and Hanscom AFB's. The preponderance of AFMC program managers are assigned to these three locations.

Names and addresses of this original sample of 573 personnel were verified by ASC/CY and ESC/CY. Survey forms were provided to this sample group by mail. Responses were requested within five weeks of the distribution date. Of this sampling of 573 personnel, 89 surveys were returned because the intended survey recipient had either moved, retired, or separated from the service. Of the remaining 484 surveyed, 243 returned usable response forms for a response rate of 50%. An additional 35 respondents returned forms incomplete or simply refused to complete the survey.

Figure 9 highlights the concentration of program management positions surveyed. The vast majority of those surveyed are currently assigned to positions in System Program Offices (SPOs) whereas one tenth of the respondents were in staff and field operating agency positions. Since the emphasis of this research was on practitioners, this appears to be an adequate sampling ratio.

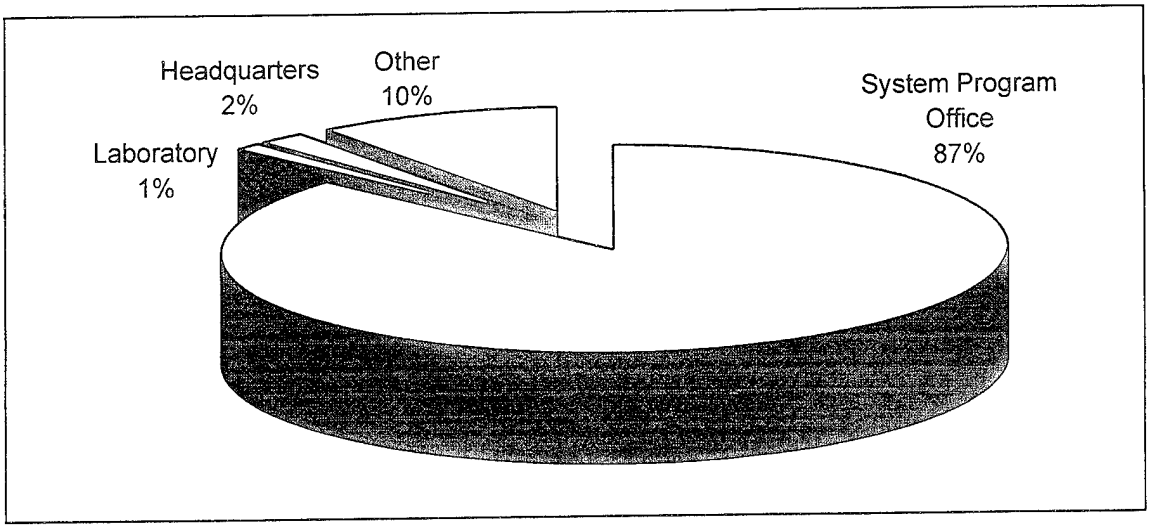

Figure 9. Percentage of Respondents by Organization Type.

The largest group of respondents had completed both a graduate management degree and either a DSMC or other program management course. As seen below, 94% of the respondents have obtained some form of management education.

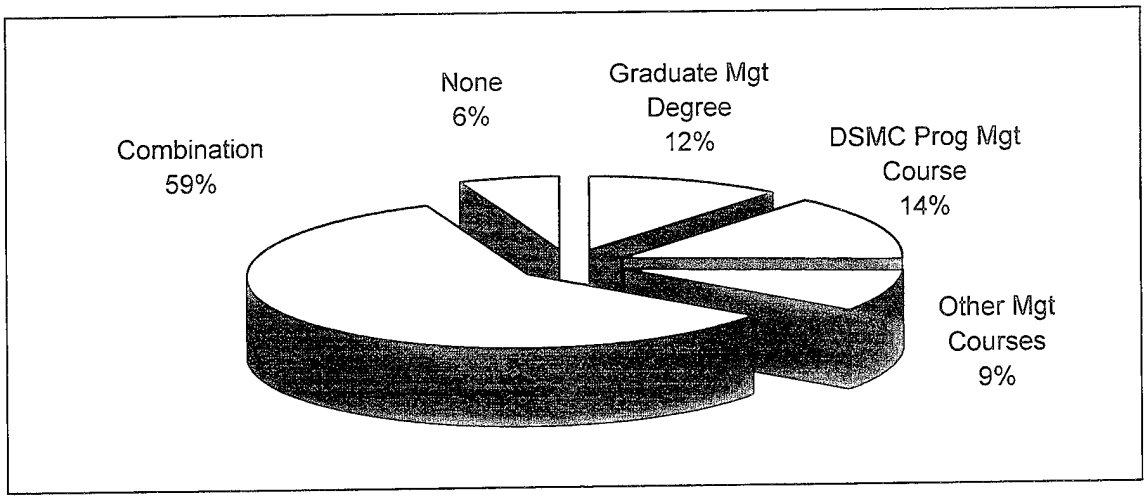

Figure 10. Percentage of Respondents by Management Education.

Consistent with the large number of respondents from SPOs, most are working with developmental and mature systems as seen in Figure 11. The remaining 20% work

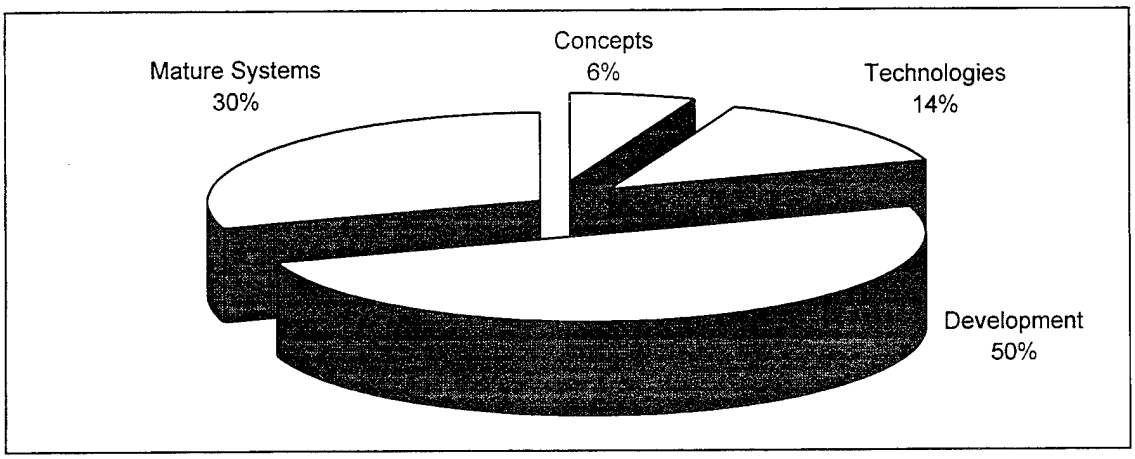

Figure 11. Percentage of Respondents by Acquisition Phase.

with the early stages of the acquisition process dealing with concepts and technologies. Again, this sampling is representative of the mix of activities within the command.

Figure 12 below indicates the majority of the respondents are responsible for planning the acquisition or monitoring the resulting contract. These two responsibilities deal directly with all five aspects of the schedule-management function. The remaining 24% were responsible for specifying requirements, evaluating proposals, and a

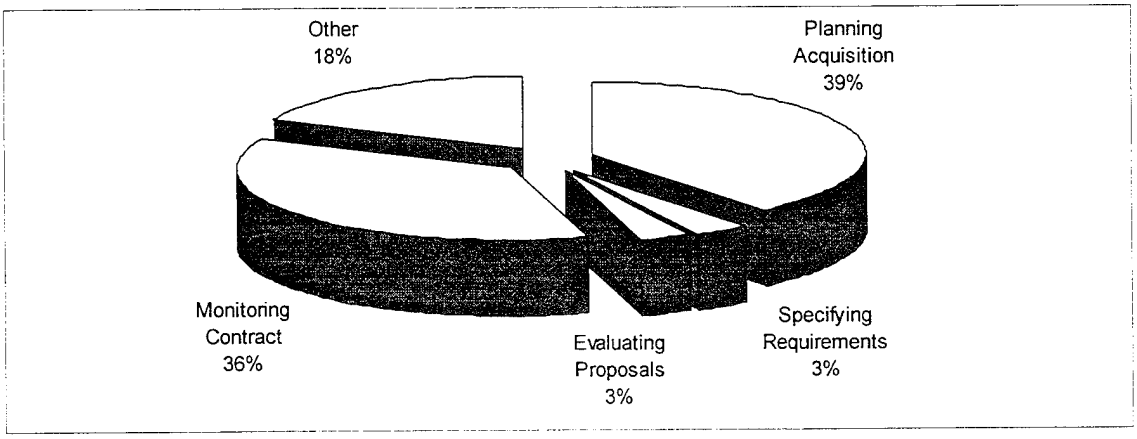

Figure 12. Percentage of Respondents by Primary Responsibility.

combination of the other areas. This again is consistent with the typical program management jobs within program offices.

Instrument Development and Testing

The primary goal of this research was the determination of the value of each competency. One of the most difficult steps in the development of the survey instrument was to determine how to assess this value. The first step was to preview survey instruments from earlier research. This approach provided the opportunity to capitalize on lessons learned through prior studies. From this initial design, meaningful response scales and question structures were drafted in a preliminary survey instrument. A pre-test provided feedback on this draft.

Competency Value

To assess the value of each competency it is necessary to understand its relative merit as well as how often the skill is used. Either appraisal alone is incomplete. While a competency may be frequently used simply out of habit or regulation, this does not provide a useful indication of its *value*. Likewise, a measure of importance alone does not indicate the necessity to actually use the skill. The two measures, frequency and importance, are both necessary and must be integrated through a decision rule (discussed later in this chapter) to adequately assess the value of each competency.

Response Scales

Perceived importance and frequency of use are the two measures reported in this survey. Responses must be provided over a *scale* of possible data values. This scale is a

"numerical representation of the values of the variable" (Kachigan, 1991:10). It is the interpretation of these numbers, rather than the numbers themselves, that make the scale useful. Scale development requires two considerations, reliability and analytical simplicity. Analytical simplicity drives the statistical analysis approach. Data can be nominal, ordinal, interval, or ratio.

There was no basis for an assumption of equal spacing between scale categories, so the data was considered ordinal. As mentioned earlier, the "Don't Know" option cannot be ordered with the other responses.

A scale is reliable if it exhibits sufficiency and completeness. Sufficiency is a measure of the range of categories. A scale is sufficient if it is neither too scattered nor precise. Meister indicates that:

> ... there is apparently no gain in reliability if one increases the number of categories from 5 to 9, but reliability drops with 3 (too gross) or more than 7 (too fine)... (Meister, 1985:326).

Completeness addresses the possibility that an answer is not covered in the provided response scale. While this seems somewhat contradictory with sufficiency, it may be covered with a simple "Don't Know" option. The problem with this option, however, is that it is not ordinal. "Don't Know" responses must therefore by excluded from the analysis requiring ordinal scales.

Frequency

The frequency response scale was initially adopted from previous survey instruments. This scale covers the expected range of responses from "annually or less"

(i.e., seldom) to "daily" (i.e., often) while addressing those that either don't know or can't relate to the question. Table 24 shows the frequency scale used in the test survey instrument.

Table 24. Frequency Response Scale.

1	2	3	4	5	6
Annually or less	Quarterly	Monthly	Weekly	Daily	Don't Know

Importance

The importance response scale was adapted from previous survey instruments. This scale covers the expected range of responses from "not important" to "extremely important" while addressing those that either don't know or can't relate to the question. Table 25 shows the scale used in the test survey instrument.

Table 25. Importance Response Scale.

1	2	3	4	5	6
Not Important	Slightly Important	Important	Very Important	Extremely Important	Don't Know

Pre-Test Instrument Structure

The survey instrument was developed using the competencies in Table 23 and scales in Tables 24 and 25. This instrument was pre-tested on a group of program management students enrolled in the Systems Management curriculum at AFIT. Their feedback provided the necessary input for instrument modifications. The pre-test survey instrument contained three sections.

The first section requested biographical information regarding the following areas:

a. management education
b. organization type
c. primary activity
d. program phase

The second and third sections of the pre-test survey instrument contained 28 questions on the importance and 28 questions on the frequency of use of the competencies respectively. Answers to these questions were given on the ordinal scales of Tables 24 and 25.

Pre-Test

The pre-test was administered to assess the average time to complete the survey, to solicit general remarks about specific question phrasing and to obtain an overall reaction to the instrument. None of the respondents reported concerns about the length of the test, but constructive comments were provided concerning the phrasing of nine questions and suggestions were made to include the following demographic questions:

a. current grade;
b. center location;
c. main product of organization;
d. principal job responsibility.

Additionally, the frequency response scale added little value in distinguishing between "weekly" and "daily." It was also suggested that the response "annually or less" included other categories that might be important to distinguish, (i.e., "don't use" or "don't have" skill). The frequency response scale was modified as shown in Table 26.

Table 26. Revised Frequency Response Scale.

1	2	3	4	5	6	7
Annually or less	Quarterly	Monthly	Weekly	Don't Use Skill	Don't Have Skill	Don't Know

Survey Methods

Just as important as a well written and concise survey instrument is the need to distribute it to a large enough group to make the responses statistically meaningful. Yet, wide distribution alone will not counter the respondent's unwillingness to complete and return the instrument. This requires a sense of obligation by the respondent to an issue he or she can relate to.

To elicit this sense of commitment from respondents, a cover letter was enclosed with the survey package soliciting timely responses. The letter identified the research as being sponsored by the Aeronautical Systems Center office for Program Management (ASC/CY). Colonel Robert C. Helt, Program Management Director, signed the cover letter. Colonel Helt is responsible for manning, training, and education of all Program Management personnel within Aeronautical Systems Center. His letter identified the survey as a method of assessing *what* and *how* schedule-management skills are being used. His letter further stressed the value of the research as a means of making changes to the command's training and education programs.

The final survey instrument was divided into four sections: biographical, importance, frequency, and open-ended questions. The biographical questions formed the basis for subgroup analysis in answer to research question two. Importance and frequency questions provided data for analysis in answer to research question one. The

last section provided space for written input on potentially omitted skills, most important and most frequently used skills, and other comments. The survey instrument distributed to the sample population is in Appendix B.

Survey Instrument Validity & Reliability

Validity and reliability are attributes that measure the performance of the constructs of the test instrument. The constructs for this survey instrument were "importance" and "frequency of use" of schedule-management competencies. Validity is "the extent to which a test measures what we actually wish to measure" (Emory and Cooper, 1991:179). Internal validity deals with the ability to measure constructs; external validity concerns the "generalizability of the results" (Emory and Cooper, 1991:179-80).

Internal Validity

Both the *description* of the competencies as well as the scale *divisions* affect the internal validity of the instrument. Questions which are too vague or precise may cause response validity errors. Inappropriate assumptions about the respondent's knowledge of terms and concepts can also be a cause of instrument errors.

To keep the test instrument simple, assumptions were made about the respondent's knowledge of the subject matter while including examples within specific questions to aid in question comprehension. It was also assumed that concepts not understood were probably not important or used. For at least one instance, this proved to be an invalid assumption. Finally, the categories of both the "frequency" and "importance" scales were evolved from previous survey instruments as modified by the

pre-test and adequately reflect the appropriate variations in both constructs. To accommodate those that did not understand a particular statement, both the "frequency" and "importance" scales included a "Don't Know" option.

External Validity

External validity pertains to generalizability. The goal of this research was to assess schedule-management competencies of military program managers (within the Air Force). While the vast majority of program managers within the Air Force are assigned to AFMC, there are a number of program managers not assigned to the three Air Force bases surveyed. Approximately 50.1% of the entire population were not contacted. It is possible that this omission included some bias in the results if program managers at these locations value different competencies than those surveyed. However, all of the reported level II and level III program managers within Aeronautical System Center, and Electronic Systems Center were surveyed and the results of this research can be directly applied to that group.

Reliability

Reliability refers to the consistency of an instrument. A measure is reliable to the degree that it supplies consistent results (Emory and Cooper, 1991:185). One evaluation of instrument reliability involves comparison of results from repeated testing to assess instrument *stability*. "A measure is said to be stable if you can secure consistent results with repeated measurements of the same person with the same instrument" (Emory and

Cooper, 1991:185). Due to the time span of this research and the impact to respondents, it was not practical to re-test the population.

Data Analysis

Data Collection

The response data were scanned electronically and saved as an ASCII file. The ASCII file is an array of 64 (number of survey questions) by N (number of responses). This file was then converted through the following three step process and made available for use by the statistical analysis software (Statistix, 1991).

1. open as MS WORD document
   - delete format characters
   - delete survey form number
   - delete end of line spaces
   - write macro to insert spaces between data
   - copy **text**
   - save file with "TXT" extension

2. open MS EXCEL
   paste **text**
   convert text to columns (under **Data**)
   format-column-autowidth
   save-as WKS (1-2-3) formatted file

3. read into Statistics as a Lotus 1-2-3 file
   - save as system file

Analysis Approach

Data analysis for this study involved two primary tasks. The first research question required analyzing the data from the entire sample by considering both frequency and importance responses individually. A decision, rule discussed below, was

then employed to combine the two concepts into a single measure of value for each competency.

Answering the second research question required evaluation of differences in the subgroup responses. The Kruskal-Wallis test was used to identify differences in the responses between subgroups of interest. This test allows non-parametric analysis of variance and has the following assumptions and hypotheses (Conover, 1980:230):

Assumptions:

1. All samples are random from within their respective populations;
2. Each sample is independent; there is mutual independence among samples;
3. The measurement scale is at least ordinal;
4. Either k population distribution functions are identical, or else some of the populations tend to yield larger values than other populations do.

Hypotheses:

H_0: All of the k population distribution functions are identical;
H_a: The k populations do not have identical distributions.

Research Question 1 Analysis

The competency model was first evaluated by analyzing the importance and frequency data individually. The median response value for each competency was calculated. Next, the portion of respondents answering four or five to the "Importance" questions and three or four to the "Frequency" questions were quantified. This classification implies the competency is at least *very important* and used at least *monthly*. A complete list of the medians and percentages can be found in Appendix C. The competencies were then ranked by this classification to highlight the most important and

frequently used competencies. A complete list of these competencies ranked by importance and frequency can be found in Appendix D.

The competency model was then evaluated by combining the frequency and importance data through a decision rule. This rule was used to integrate these two constructs into a single measure subjectively reflecting the value of each competency. Both constructs were weighted equally in the decision rule.

> **Decision Rule:** Competencies are considered valuable if both of the following were true:
>
> a) at least 50 percent of the respondents considered the competency important (with a median of 3 or greater) and
>
> b) at least 50 percent used the competency (median of 4 or less).

This rule generated a list of competencies which should be considered "valuable" to practicing program managers. A complete list of the medians and percentages can be found in Appendix E.

Research Question 2 Analysis

The second research question required variance analysis to evaluate differences in the competencies required of program managers as a function of management education, organization type, acquisition phase, principal job responsibility, and current grade.

The Kruskal-Wallis test (described earlier) was used to answer research question number two. Rejection of the null hypothesis indicates that the subgroup responses were not identically distributed. This implies that the subgroups did not find the competency equally important or did not use the competency with equal frequency. A level of

significance of .05 was used to accept or reject the null hypothesis. Probability (p) values for the test are provided in Appendix F.

Summary

An objective of this research was to improve the education and training programs for program managers in the area of schedule-management. A model was developed and tested through a survey of 484 intermediate and senior level program managers within AFMC. Data analysis provided identification of valuable schedule-management competencies and variations among program managers with different management education, organization types, acquisition phases, principal job responsibilities, and current grade level.

The next chapter discusses the research findings and the analysis by both frequency and importance factors individually as well as a composite assessment of each competency value. Sub-category classification data was analyzed to ascertain trends between classification groups.

IV. Findings and Analysis

Introduction

This study focused on two major research objectives: identifying valuable schedule management competencies and observing differences in responses among subgroups of the population. The perceptions of 243 program managers were used to answer these two questions. Survey analysis indicates that 25 of the 28 competencies in the model were valuable to program managers. The study also evaluated differences in the perceived importance, frequency of use, and value of these competencies based on acquisition phase, primary responsibility, and grade level.

Research Question 1

Answering the first research question involved analysis of the frequency and importance data individually. This data was then combined and analyzed through the use of a decision rule which integrated frequency and importance responses into a single measure of value. A complete list of the medians, means, and other descriptive statistics is provided in Appendix G and H for each of the competencies.

Frequency

The frequency data was ranked based on the percentage of respondents using each competency Weekly or Monthly. Tables 27 and 28 present the 10 most frequently and 10 least frequently used competencies respectively. These tables show that program managers perform top-level planning functions most frequently with less frequent use of the many tools available (such as the WBS, CPM, heuristics, PERT, simulation, and

statistical analysis) to ensure time and budget constraints are satisfied and lessons learned from previous program failures are properly considered. Additionally, program managers more frequently *brief* schedule status than they use the competencies necessary to *understand* schedule performance or its impact on program costs (earned value). This is evident by the frequency with which program managers *understand* the concepts vice how often they actually *perform* the tasks!

Table 27. Most Frequently Used Competencies.

Competency	Percent Using Weekly or Monthly
1.1 define tasks to be performed to meet project objectives	75.3
5.1 construct information briefings to relay schedule status	74.9
2.1 allocate scarce resources over the period of the project	72.4
1.2 determine sequence and precedence relationships of project tasks	70.4
5.3 understand the impact of changes in scope on schedule performance	69.1
5.10 understand the impact of schedule slippages on performance and cost objectives	67.4
3.1 estimate duration of tasks	65.4
4.6 detect insufficient schedule for work defined	62.1
3.2 understand the implications of uncertainty associated with task duration estimates	62.1
4.2 schedule distinct, measurable, identifiable milestones	61.3

While three of the top ten most used competencies are in the area of time control, one of these three is simply the communication of project status (not the actual assessment process). Additionally, the other two "control-related" functions are comprehension-level (not application-level) competencies. This suggests that program managers are more often *aware of* schedule impacts than they actually perform the *assessment* of schedule status. Additionally, Table 27 reveals that program managers spend more time planning tasks (defining, sequencing, and estimating task duration) and developing schedules than they actually monitor and control the resultant effort.

Table 28 indicates that the nine *least* frequently used competencies all require *application* of knowledge and skills. These working-level competencies are required to be able to successfully accomplish all of the ten most frequently used competencies! If program managers aren't using these competencies, how are they accomplishing the top ten most used?

Table 28. Least Frequently Used Competencies.

Competency	Percent Using Weekly or Monthly
5.4 understand the concept of earned value and methods for calculating it	35.0
5.7 compute schedule performance index to assess schedule efficiency	23.8
3.4 use CPM to reduce the project schedule consistent with budgetary constraints	22.2
2.2 construct a project network diagram representing tasks and their precedence relationships	21.0
4.3 use heuristics to develop a schedule that is achievable given existing constraints	18.1
3.3 use PERT to estimate project duration	16.9
3.5 use computer simulation to develop and analyze estimates of project duration	11.9
4.4 use statistical analysis methods to characterize uncertainty associated with schedule estimates	8.7
1.3 develop a work breakdown structure describing the project work effort	7.8
4.5 distribute the cost of work packages across the project schedule to develop PMB	7.0

Perhaps the most important finding from Table 28 is the limited value placed on developing the work breakdown structure (WBS) which is the foundation for the project statement of work (SOW) and the resultant contracted effort to be managed. Yet the most frequently used competency is defining the tasks to be performed! How are program managers defining these tasks if not through a WBS?

Importance

The importance data was ranked based on the percentage of respondents who indicated that the competency was *Very Important* or *Extremely Important*. Tables 29

and 30 present the 10 most important and 10 least important competencies on this basis. These tables indicate that half of the most important competencies are top-level and "control-related," while *all* of the least important competencies are "mechanics" type competencies. This suggests that program managers believe the "control-related" competencies are more important than the up-front planning and schedule development competencies; yet those competencies necessary to perform these "control-related" tasks are viewed as less important. If program managers view these "mechanical competencies" as less important, who is ensuring these lower-level tasks are being performed? Many of the "control-related" tasks rely on these lower-level competencies.

Table 29. Most Important Competencies.

Competency	Percent Rating Very or Extremely Important
1.1 define tasks to be performed to meet project objectives	92.2
4.2 schedule distinct, measurable, identifiable milestones	82.3
1.2 determine sequence and precedence relationships of project tasks	81.9
5.3 understand the impact of changes in scope on schedule performance	81.1
5.1 understand the impact of schedule slippages on performance and cost objectives	79.9
2.1 allocate scarce resources over the period of the project	79.8
5.8 develop corrective actions to counter unfavorable program variances	74.8
5.2 perform trades between cost, schedule, and performance	73.2
4.6 detect insufficient schedule for work defined	69.2
5.6 determine if schedule variation requires corrective action	66.7

Table 30 illustrates the limited importance placed on *application* oriented competencies. All ten of the least important competencies require application of knowledge and skills.

Just as the most frequently used competency is defining tasks to be performed, program managers also place the highest importance on this competency. Also consistent

with the second least frequently used competency, program managers place less importance on their ability to develop the WBS. This suggests that program managers are relying on someone else to develop the SOW. Perhaps the contractor!

Table 30. Least Important Competencies.

Competency	Percent Rating Very or Extremely Important
4.7 use schedule management software tools	41.5
2.2 construct a project network diagram representing tasks and their precedence relationships	39.9
3.4 use CPM to reduce the project schedule consistent with budgetary constraints	38.7
5.5 compute schedule variances	34.2
4.3 use heuristics to develop a schedule that is achievable given existing constraints	28.0
4.5 distribute the cost of work packages across the project schedule to develop PMB	27.6
3.3 use PERT to estimate project duration	25.5
5.7 compute schedule performance index to assess schedule efficiency	24.7
3.5 use computer simulation to develop and analyze estimates of project duration	17.2
4.4 use statistical analysis methods to characterize uncertainty associated with schedule estimates	14.0

Upon investigating further, it is clear that there are a number of competencies that program managers either do not use or simply do not have. Over ten percent of the program managers indicated that there are six competencies they did not possess. These competencies are all applications oriented and are listed below in Table 31.

Table 31. Competencies not Possessed by Program Managers.

Competency	Percent Not Possessing
4.5 distribute the cost of work packages across the project schedule to develop PMB	11
4.3 use heuristics to develop a schedule that is achievable given existing constraints	13
4.7 use schedule management software tools	13
5.7 compute schedule performance index to assess schedule efficiency	13
3.5 use computer simulation to develop and analyze estimates of project duration	15
4.4 use statistical analysis methods to characterize uncertainty associated with schedule estimates	15

In addition to competencies not possessed, over 20% of the program managers surveyed indicated that ten of the 28 competencies were not used at all. These competencies are listed in Table 32 below.

Table 32. Competencies not Used by Program Managers.

Competency	Percent Not Used
1.3 develop a work breakdown structure describing the project work effort	21
5.4 understand the concept of earned value and methods for calculating it	23
4.3 use heuristics to develop a schedule that is achievable given existing constraints	25
5.5 compute schedule variances	25
3.4 use CPM to reduce the project schedule consistent with budgetary constraints	25
3.5 use computer simulation to develop and analyze estimates of project duration	31
3.3 use PERT to estimate project duration	32
4.4 use statistical analysis methods to characterize uncertainty associated with schedule estimates	33
4.5 distribute the cost of work packages across the project schedule to develop PMB	33
5.7 compute schedule performance index to assess schedule efficiency	35

As illustrated in the table above, computer simulation, PERT, and statistical analysis methods, distributing cost of work packages, and computing schedule performance indexes were not used by more than 30% of the respondents.

These unused and non-possessed competencies require application of knowledge and skills. This suggests competencies requiring comprehension are used more often and considered more important than those requiring application of knowledge and skills.

Decision Rule

A decision rule provided a means for combining the concepts of frequency and importance into a single measure of value for the competencies. The decision rule considered the competency valuable if both of the following were true: a) at least 50 percent of the respondents considered the competency important (with a median of 3 or

greater) and b) at least 50 percent actually used the competency (median of 4 or less). Using this rule, 25 of the 28 competencies were considered valuable. A complete list of the median sums is provided in Appendix H.

Competency Groups

Tables 33 through 35 group the competencies into three tiers by using the decision rule above. Tier One competencies are those with a combined importance and frequency of use average of 90% or greater. Tier Two competencies have a combined importance and frequency of use average of less than 90% but greater than 56%. Tier Three competencies are not considered valuable and have an average value of less than 56%. Appendix I lists the averages for all three groups.

Tier One competencies are considered the most valuable. Table 33 indicates that 98.2% of those surveyed indicated that defining tasks was the most valuable schedule-management competency.

Table 33. Tier One Competencies (Most Valuable).

Valuable Competencies with Average of 90% or Greater	Value (%)
1.1 *Define* tasks to be performed to meet the project objectives	98.2
1.2 *Determine* sequence and precedence relationships of project tasks	97.2
4.2 *Schedule* distinct, measurable, identifiable milestones	95.1
2.1 *Allocate* scarce resources over the period of the project	95.0
5.3 *Understand* the impact of changes in scope on schedule performance	94.0
5.10 *Understand* the impact of schedule slippages on performance and cost objectives	92.8
3.1 *Estimate* duration of tasks	91.5
3.2 *Understand* the implications of uncertainty associated with task duration estimates	91.2
5.1 *Construct* information briefings to relay schedule status	91.1
4.6 *Detect* insufficient schedule for work defined	91.0
5.2 *Perform* trades between cost, schedule, and performance	90.8

Tier Two competencies are those with a combined importance and frequency average between 56% and 90%. Again, expressed importance and frequency of use must both be 50% or greater to be considered valuable. Table 34 list these competencies.

Table 34. Tier Two Competencies (Valuable).

Valuable Competencies with Average Value Less Than 90%	Value (%)
5.8 *Develop* corrective actions to counter unfavorable program variances	88.6
5.6 *Determine* if schedule variation requires corrective action	85.8
5.11 *Understand* the relationship between contract mods and the PMB	80.0
4.1 *Construct* timetables such as Gantt charts	78.9
5.9 *Interpret* contractor cost reports (such CPR and CSSR)	77.6
1.3 *Develop* a WBS that describes the project work effort	75.2
4.7 *Use* schedule management software tools	73.3
2.2 *Construct* a project network diagram representing tasks and their precedence relationships	72.9
5.4 *Understand* the concept of earned value and methods for calculating	72.1
3.4 *Use* CPM to reduce the project schedule consistent with the budget	70.6
5.5 *Compute* schedule variances	67.7
3.3 *Use* PERT to estimate project duration	60.3
4.3 *Use* heuristics to develop a schedule that is achievable	59.7
4.5 *Distribute* the cost of work packages across the project schedule to develop a performance measurement baseline (PMB)	56.4

Tier Three competencies are those with a combined importance and frequency of use average of less than 56%. Table 35 lists the competencies in this category. These competencies have less than 50% expressed importance or frequency of use and are considered not valuable by those surveyed.

Table 35. Tier Three Competencies (Not Valuable).

Competencies Not Considered Valuable	Value (%)	Percent Not Possessing
5.7 *Compute* SPI to assess schedule efficiency	55.7	13
3.5 *Use* computer simulation to develop and analyze estimates of project duration	50.4	15
4.4 *Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	46.1	15

An interesting observation from Table 35 is the nature of the three competencies from the model considered not valuable. All three are applications oriented. Each are necessary to be performed in order to be successful at other competencies requiring the output from these efforts. For example, if statistical analysis methods are not used to characterize uncertainty associated with schedule estimates, nearly every other schedule development and time control competency in the model may be directly impacted. It is difficult to detect insufficient schedule if schedule uncertainty has not first been characterized.

Another interesting observation from Table 35 is the fact that these three competencies are not possessed by more program managers than any other competency in the model and are among the least used. This suggests that program managers may either be unaware of the value of these competencies, or simply that someone else is performing the tasks.

Don't Know

The "don't know" option was provided for both the frequency and importance response scales to accommodate those who did not understand, or were not familiar with, the competency. As seen in Appendix J, less than 5% of the responses for any individual competency were classified "don't know." The percentage of "don't know" responses averaged less than 2% for both frequency and importance competencies. This indicates the vast majority of respondents understood the competency statements in the model.

Model Categories

The schedule-management competency model adopted for this research contained five major areas. Figure 13 depicts the percentage of competencies within each of these major areas that were considered valuable according to the decision rule.

This figure illustrates the relative value of task definition, task sequencing, and time control as compared to duration estimating and schedule development according to the decision rule. It also indicates that duration estimating and schedule development are two areas considered less important and used less often by military program managers.

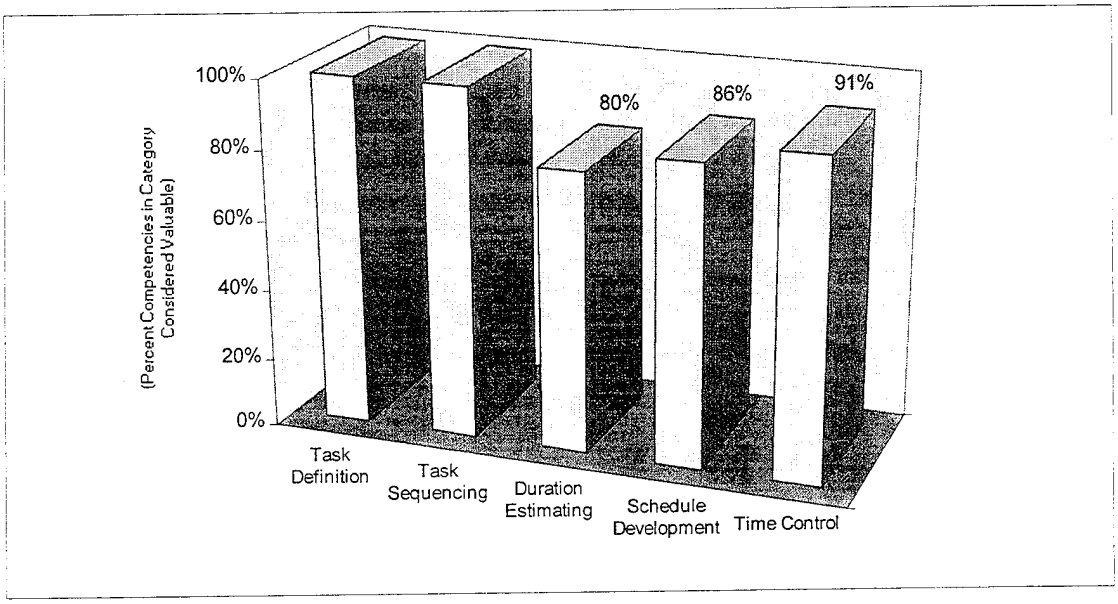

Figure 13. "Valued" Competencies by Model Category.

Comprehension vs. Application

The schedule-management model developed for this study includes competencies at both the comprehension and application levels of learning. Five of the 28 competencies in the model require only a comprehension of principles. All five of the

comprehension competencies were considered valuable while only 87 % of the application competencies were considered valuable. This result clearly indicates that more value is placed on understanding principles than actually applying the necessary skills.

Research Question 2

The second research question analyzed differences in the responses between subgroups of the sample. The Kruskal-Wallis test for non-parametric analysis of variance was used to compare the response distributions of the subgroups. This test provides p-values which represent the smallest level of significance that would result in rejection of the hypothesis that the response distributions are the same. Appendix F contains the p-values for these tests.

Results Overview

The subgroup analysis focused on differences in responses based on different acquisition phases, primary responsibility, and current grade. The tests compared the subgroup response distributions for each of the 28 importance and 28 frequency questions and their composite values. None of the competencies were rated as "not important."

Acquisition Phases

There were a number of competencies for which the perceived importance, frequency of use, and value varied with different acquisition phases. In particular, those program managers working in concept exploration and mature (production) efforts tended

to value different competencies than those working technology demonstration and development efforts.

Frequency of Use

Numerous differences were noted between how often the competencies were used based on where in the acquisition phase the program manager is currently working. Appendix K lists the median value of usage for each of the competencies based on acquisition phase.

Thirteen of the competencies are not being used by the majority of the program managers working in the concept exploration phases. Another striking difference is that these program managers use the other competencies at least as often as the other program managers and they actually use ten competencies more often than the others.

Program managers working on the technology demonstrations use *all* of the competencies at least annually and on average at least monthly. Program managers working in the development phase tend to use most of the competencies at least monthly and with the exception of not using statistical analysis, they use all other competencies at least annually.

Program managers working in the production phase use *most* of the competencies at least annually and on average between monthly and weekly. These program managers don't use four of the competencies. All four of these competencies are also not used by those working in concept exploration phase. In particular, with the exception of program

managers working in technology demonstrations, all other program managers don't use statistical analysis methods to characterize uncertainty in schedule estimates.

Importance

Differences were also noted between how program managers working on different acquisition phases view the importance of the competencies. Appendix K lists the median value of importance for each of the competencies based on acquisition phase.

Program managers working on technology demonstration and development rated each competency as at least important with the majority considered at least very important. Those working in development tended to rate a few of the competencies more important than those working technology demonstration.

Only those program managers working either concepts or mature programs viewed any of the competencies as less than important. Using statistical analysis was viewed as only slightly important by both concept and mature categories while distributing the cost of work packages was considered slightly important only by program managers working concepts.

Value

Program managers working concepts viewed thirteen of the competencies as not valuable. While they viewed only two of the competencies to be only slightly important, the frequency with which they used many of the competencies seriously reduced the number they considered valuable. Appendix K lists the median value of computed value for each of the competencies based on acquisition phase.

Program managers working mature systems found five competencies as not valuable. Two were considered not valuable by program managers working development and only one was considered not valuable by those working technology demonstrations. This same competency was considered not valuable by all program managers except those working concepts. Although all four groups considered this competency important, none used the competency more than annually (except those working concepts) This is probably due to the short nature of those types of efforts.

A final curious finding is the fact that all of the program managers working concepts viewed computing schedule performance index as not valuable. This competency was not used by those program managers while this competency was used at least monthly by the other program managers.

Primary Responsibility

There were also many indications that program managers view competencies differently based on their primary responsibility.

Frequency of Use

Numerous differences were noted between how often the competencies were used based on different primary responsibilities. Appendix L lists the median value of usage for each of the competencies based on primary responsibility.

Seven of the competencies are not being used by program managers; two for those planning, five by those specifying requirements, three for those evaluating proposals, and only one for those monitoring contracts. Those specifying requirements

and evaluating proposals do not use heuristics, statistical analysis, or schedule performance indexes.

There appears to be similarity between those specifying requirements and those evaluating proposals. There also appears to be similarity between those planning acquisitions and those monitoring contracts. Program managers primarily planning and monitoring less frequently develop WBS and use computer simulation than those specifying and evaluating. Additionally, program managers primarily specifying and evaluating less frequently use heuristics, statistical analysis, and compute schedule performance index than those planning and monitoring.

Importance

Differences were also noted between how program managers with different primary responsibilities view the importance of the competencies. Appendix L lists the median value of importance for each of the competencies based on primary responsibility.

Program managers responsible for monitoring contracts rated each competency as at least important with the majority considered at least very important. Those responsible for planning acquisitions and evaluating proposals rated only one of the competencies as only slightly important while those responsible for specifying requirements rated six of the competencies as only slightly important. Computer simulations and statistical analysis were two competencies seldom used.

Value

The pattern of similarity between subgroups observed in the frequency of use results was also evident in the competency value classifications. Those specifying requirements and those evaluating proposals had similar values as well as those planning acquisitions and those monitoring contracts. Program managers primarily planning and monitoring did not value WBS development and computer simulation. Additionally, program managers primarily specifying and evaluating did not value the use of heuristics, statistical analysis, and computing schedule performance indexes.

Current Grade

Program managers at the various grade levels also view many competencies differently. In particular, all three of the competencies viewed as not valuable by the majority of respondents were also considered not valuable by Colonels. For simplicity, 2Lt's, 1Lt's, and Capts were combined as representing Company Grade Officers.

Frequency of Use

Numerous differences were noted between how often the competencies were used based on grade level. Appendix M lists the median value of usage for each of the competencies based on grade.

Colonels did not use five of the 28 competencies while Lieutenant Colonels did not use only one of them. Majors and company grade officers used all of the competencies at least quarterly except for allocating scarce resources over the period of the project. This competency was used annually or less by company grade officers.

Company grade officers and Majors used (at least quarterly) all of the competencies not used by Colonels. Computer simulation was used at least weekly by the majority of Majors and Lieutenant Colonels while company grade officers used this competency at least quarterly and Colonels did not use it at all. Statistical analysis was used primarily by Majors while company grade officers used this competency at least quarterly and Lieutenant Colonels and Colonels did not use it at all. Computing schedule variances and performance indexes was used at least monthly by all but Colonels.

Importance

Few differences were noted between how program managers at various grade levels view the importance of the competencies. Appendix M lists the median value of importance for each of the competencies based on primary responsibility.

One of the competencies (using statistical analysis) was considered only slightly important by both company grade officers and Lieutenant Colonels. All other competencies were considered at least important. All four grade categories rated the importance of each competency equally with minor variances.

Value

Between three of the four categories, six of the competencies were rated as not valuable. Majors rated all 28 competencies as valuable. Company grade officers and Lieutenant Colonels rated two of the competencies as not valuable (developing WBS and using statistical analysis tools). Colonels rated five of the competencies as not valuable.

Summary of Findings

Three competencies were found to be not valuable to program managers. These three included: using computer simulation, statistical analysis, and computing schedule performance indexes. The make up of program managers who did not value these competencies is listed in Table 36 below.

Table 36. Not Valued Competencies.

Competencies Considered Not Valuable	Acquisition Phase	Primary Responsibility	Grade Level
5.7 *Compute* schedule performance index to assess schedule efficiency	concepts	specifying & evaluating	**Colonels**
3.5 *Use* computer simulation to develop and analyze estimates of project duration	concepts & mature systems	**planning & monitoring**	**Colonels**
4.4 *Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	concepts, **development & mature systems**	specifying & evaluating	Company Grade Officers, **Lt Colonels, Colonels**

While Colonels make up only 16% of the surveyed population, their value rating on all three of the above competencies was a major contributing factor to these competencies being rated as not valuable. Those working concepts make up only 0.05% of the population while those specifying requirements and evaluating proposals make up 0.07%. Clearly, there were program managers in the other categories which did not value computing schedule performance indexes.

Colonels and program managers performing the planning and monitoring functions comprise the majority of those not valuing computer simulations. Those

planning make up 39% of the population while those monitoring contracts make up 36% of the population. Those working development system comprise 50% of the surveyed population. Between these program managers and Lt Colonels and Colonels, statistical analysis methods are not considered valuable.

Other Remarks

In addition to the eight biographical and fifty-six competency questions, the survey solicited comments from respondents. Appendix N lists these comments. The responses varied from topic areas omitted from the original model to new concepts that had not been considered. Tables 37-39 summarize the topic areas in the responses.

Table 37. Open-Ended Response Topics - Omitted Competencies.

Topic Area	Frequency
Personnel management, team leadership, motivation, and communication skills	12
line of balance, schedule integration	6
Types of software tools and their benefits/drawbacks	6
balancing resource allocation to changing priorities and individual's abilities/cost	4
relationship between requirements, cost estimating, and schedule planning	3
outside influences on schedule management	2
how you relate schedule performance to award fee determination	2
schedule validation methods	2
leadership and TQM processes that influence schedule	2
IPTs in PM	1
metrics	1
PMD, COEA, and Acquisition strategy	1
early planning emphasis on project cost reduction	1
integrated master plan development & usage	1
integrated master schedule development & usage	1

Table 38. Open-Ended Response Topics - Most Important Competencies.

Topic Area	Frequency
schedule evaluation and cost/schedule/performance trades developing workarounds	21
task identification and definition	18
developing plan and associated schedule	14
communication through regular program/process reviews and progress reports	14
understanding/tracking the critical activities (CPM)	13
identify/track critical milestones	12
PERT	8
estimating task duration	7
ability to effectively use project management software	7
interpretation of CSSR/CPR data	6
task relationship, prioritization, and sequencing	6
IMP and IMS tracking	4
execution of the planned schedule	3
constructing information briefings to relay schedule status	3
ensuring ownership of everyone involved to reach the final objectives	2
leadership - keeping people motivated to do the tasks necessary to succeed	2
earned value or CSS	2
risk management	2
schedule integration across programs	2
allocation of limited resources	2
using indices to monitor performance & reviewing progress against PMB	1
timely flow of information that supports schedules	1
getting contractors to take action to lessen impact of bottlenecks	1

Table 39. Open-Ended Response Topics - Most Used Competencies.

Topic Area	Frequency
determine corrective action to variances (cost/schedule/performance trades)	6
constructing information/status briefings	4
critical path analysis	4
Gantt chart development	3
communication through regular program/process reviews and progress reports	3
schedule management software tools	2
milestone schedules	2
determine sequence and precedence of project tasks	2
assess progress (milestone accomplishment and earned value)	2
CPR	2
CSS	1
define tasks to be performed to meet objectives	1
allocate scarce resources over the period of the project	1
whatever the audience is perceived as wanting to hear	1
estimating task duration	1

The most commonly addressed area was evaluating schedules and developing cost/schedule/performance workarounds when problems arise. Task identification and definition and developing program plans and schedules were also of great interest. Personnel management, teamwork, and communication skills were also expressed as valuable competencies as were identifying/tracking critical milestones and activities. Several respondents expressed interest in personnel management, team leadership, motivation, and communication skills. Since these topics are not directly related to schedule-management, it is not recommended that the model be modified to include them.

Conclusion

The data provided by 243 respondents indicates that 25 of the 28 competencies in the model are considered valuable by military program managers within Air Force Materiel Command. A number of the comments provided by those surveyed indicate that in many instances the program managers are not the individuals actually performing the schedule-management tasks. Some indicated that there were other *specialists* on their team who performed these tasks. Most, however, indicated that they rely on the contractor to perform these tasks and they merely monitor the contractor's work. While this is not an entirely ideal situation, it is even more dangerous if the military program manager does not know *how* to perform the tasks.

V. Conclusions and Recommendations

Introduction

Defense acquisitions have historically accounted for more than a third of the DoD budget (Cheney, 1993:143). The magnitude of money involved and the exceptionally negative publicity resulting from catastrophic failures make schedule-management critical to the success of DoD acquisition programs. This research effort was conducted to evaluate the schedule-management competencies valued by Air Force program managers. The research focused on two major research questions: What schedule-management competencies do program managers perceive to be valuable, and how do these perceptions vary among subgroups of the population.

In order to answer these two questions, a 28 element schedule-management competency model was developed based on previous management research. The principal resources were the Project Management Institute's Project Management Body of Knowledge and the Acquisition Management Functional Board competency list. A notable characteristic of the model was the differentiation between the ability to perform a task and the ability to understand the results of the completion of a task.

The perceptions of Air Force program managers were compiled through a mail survey designed to determine the perceived importance and frequency of use of the 28 competencies in the model. The survey was distributed to 484 intermediate and senior level program managers in Air Force Materiel Command. A total of 243 program

managers responded. The remainder of this chapter summarizes the results of the study and provides some conclusions, recommendations, and suggestions for future study.

Results

Each competency in the model was evaluated based on the survey data, first assessing perceived importance then frequency of use. Next, the *value* of each competency was determined through a decision rule which combined the perceived importance with frequency of use.

The competency model consisted of five major areas: Task Definition, Task Sequencing, Duration Estimating, Schedule Development, and Time Control. Task Definition and Sequencing showed the highest proportion of valuable competencies (100%), followed by Time Control (91%), Schedule Development (86%), and finally Duration Estimating with 80% of the competencies considered valuable. Variations in responses were examined based on three factors: acquisition phase, primary responsibility, and grade level.

Conclusions

The data provided by the 243 respondents indicates that 25 of the 28 competencies were considered valuable by practicing military program managers. Every competency in the model consisted of two aspects: perceived importance and frequency of use. Some of the competencies were perceived to be important but were not frequently performed by the program manager. Support staff and greater reliance on the contractor may contribute to limited use of the competencies. There were also some competencies

which were utilized frequently though they were relatively unimportant. Policies, procedures, and formal direction may contribute to this occurrence.

The number of response distribution differences identified in each biographic category varied. However, less than 6% of all the Kruskal-Wallis tests identified variations in the perceived importance or frequency of use of competencies based on acquisition phase, primary responsibility, and grade level. The respondents also produced a number of topic areas that should be considered for inclusion in future schedule-management competency models. The results of the survey indicate the need for specific training and certifications programs to ensure critical acquisition positions are filled with qualified professionals.

Education and Training

While on the job training can be an effective method for transferring application-specific knowledge, more formal training is generally the preferred method for providing the standard skills necessary to manage programs. Education and training programs are therefore essential to ensure professionals are competent and fully qualified; yet these programs can tie up valuable resources and are expensive to operate. They must therefore be designed to provide only the necessary schooling to facilitate practical application of the fundamentals. This research has identified those schedule-management skills which are deemed valuable to practicing program managers. The optimum training method must now be determined through further research.

Certification Programs

Much of the literature discusses the pros and cons of program management certification programs aimed at classifying an individual as an acquisition professional with associated training, experience, and expertise. In fact the commercial sector has formalized the process through the Project Management Institute with certification training and tests. One of the objectives of this certification is to enforce a standard with a universal classification of the concept "professional."

The DoD Acquisition Professional Certification is an attempt to standardize acceptable levels of education, training, and experience. Program management positions are coded with the desired certification level necessary to perform the duties. This certification provides a path for progression within the profession while standardizing levels of competency.

This of course presumes that those meeting the criteria for certification are qualified for all positions at that level. Unfortunately, since there are only three levels of certification, the criteria are quite general. For example, no criteria exists for specific functions within program management such as cost or schedule-management. This is probably as it should be since management of certification below the general level would take more resources than economically feasible to administer. Hence, certification should continue to be a general indication of an individual's qualifications while individual qualifications and experience must continue to play an important role in the selection of program managers for specific positions

Recommendations

The results of this research have direct implications for AFMC program managers. In so far as AFMC program managers are similar to defense program managers, the results of this research may find a broader base of applicability. The findings are relevant to the education and training of program managers and their professional certification.

Education and training programs consume time and money. The goal of these programs should be to develop the competencies that will provide the most benefit to program managers on the job. Once the most important competencies have been identified (for all program management competencies), the best method to convey the information must be determined. Determining the optimum training method for the important competencies identified in this study would require further research as discussed below. In the meantime, there are opportunities to improve our current programs by recognizing what is important to program managers (and conversely, what is not).

In order to receive the maximum return on investment, these education and training programs should be focused on the competencies that will prove most valuable to program managers in their jobs. The 25 valuable competencies identified in this study coupled with the 29 identified in the cost-management study conducted by Baxter and Bolin can serve as a foundation for this training.

There are many opportunities for continuing this research. They include modification and refinement of the model, expanding the research to a broader population, extending the research to other functional areas, and increasing the depth of the research by considering level of competency and training.

Follow-on Research

Modifying the Model

Survey responses indicated additional areas warranting incorporation in the model. While incorporation of all the suggested areas would tend to make the model too broad and unmanageable, a few of the more frequently suggested topic areas may warrant further investigation. Further research integrating these few topic areas into a revised model could provide the basis for direct comparison with the results of this study.

Another aspect of the model development which required great perseverance is in determining the appropriate level of indenture for each competency. Less important topic areas can be addressed at a top level while more important (complex) topics might be covered in greater detail. The results of the current research can be used to develop a refined model focusing more on the most valuable competencies.

There were several comments about the "whole-person" concept of project management which incorporates all the functional disciplines. Focusing exclusively on cost, schedule, or performance will not guarantee success. Extracting the most valuable competencies from this research and combining them with those of other aspects of

project management may provide a verification of all the top-level competencies necessary for program management.

Broader Population

To expedite the research and control the results, the survey was confined to the three primary installations in which the majority of acquisition programs for AFMC reside. Broadening the applicability of the research and expanding the survey population to other AFMC bases may confirm the results of this study to all of AFMC.

Additionally, since DoD civilian employees also perform program management duties, broadening the research beyond the military may provide another perspective not captured by the active duty population alone. Military population may have a broader application base, while civilians are likely to have more depth of experience. It is likely that these two populations may value different competencies. Identifying differences between these two groups could highlight education and training deficiencies.

Broadening the research beyond the AFMC and the Air Force will foster validation (and refinement) of the model and address DoD certification, training, and education problems. There is a risk, however, that the broader the population base, the more generic the results may become.

Other Skill Areas

As clearly indicated by a number of survey respondents, schedule-management is only one of many program management disciplines. Best and Kobylarz developed a Defense Body of Knowledge which divides program management into a number of skills

areas. Baxter and Bolin developed a cost-management model and this research developed a schedule-management model. Other skill areas include quality, engineering, manufacturing, logistics, and software management.

Education and Training

This study assessed the perceived importance and frequency of use of schedule-management competencies. This provided evidence of those schedule-management competencies deemed valuable to program managers. Now it is assumed that some method of obtaining the competency is desirable, and the most cost effective approach is the preferred method. Determining the desired method for each competency is the next area of research. This may involve an examination of how, where, and when the skill was obtained (i.e., through on-the-job-training, or more structured training or education program) and whether that approach was beneficial or if a different approach is preferred.

Appendix A: Glossary

Acquisition. The planning, design, development, testing, contracting, production, introduction, acquisition logistics support, and disposal of systems, equipment, facilities, supplies, or services that are intended for use in, or support of military missions.

Acquisition Corps. A subset of DoD Component's acquisition workforce, composed of selected military and civilian personnel in grades of Lieutenant Commander, Major, General Schedule and/or General Manager (GS/GM) 13 and above, who are acquisition professionals. There is one Acquisition Corps for each Military Department and one for all the other DoD Components (including the OSD and the Defense Agencies).

Acquisition Experience. Experience gained while assigned to an acquisition position. Also includes intern, exchange, education or training with industry, and other acquisition developmental assignments. Includes experience in DoD acquisition positions and in comparable positions outside the Department of Defense.

Acquisition Organization. An organization, including its subordinate elements, whose mission includes planning, managing and/or executing acquisition programs which are governed by DoD Directive 5000.1, DoD Instruction 5000.2, and related issuances.

Acquisition Positions. Civilian positions and military billets that are in the DoD acquisition system, have acquisition duties, and fall in an acquisition position category established by the USD(A). While most frequently located in organizations having an acquisition mission, acquisition positions are also located in management headquarters organizations, management headquarters support organizations, and other organizations.

Acquisition Program. A directed, funded effort that is designed to provide a new or improved materiel capability in response to a validated need.

Acquisition Workforce. The personnel component of the acquisition system. The acquisition workforce includes permanent civilian employees and military members who occupy acquisition positions, who are members of an Acquisition Corps, or who are in acquisition development programs.

Baseline. Defined quantity or quality used as starting point for subsequent efforts and progress measurement. Can be a technical cost or schedule baseline.

Budget. A comprehensive financial plan for the Federal Government, encompassing the totality of Federal receipts and outlays (expenditures). Also a plan of operations for a fiscal period in terms of (a) estimated costs, obligations, and expenditures; (b) source of funds for financing including anticipated reimbursements and other resources; and (c) history and workload data for the projected program and activities.

Certification. A process through which it is determined that an individual meets all the education, training, and experience standards established for his or her acquisition career field or position, or for membership in an Acquisition Corps.

Critical Acquisition Position. Those senior positions carrying significant responsibility, primarily involving supervisory or management duties, in the DoD acquisition system. Those positions are designated by the Secretary of Defense, based on the recommendations of the DoD Component Acquisition Executives, and include any acquisition position required to be filled by an employee in the grade of GS/GM 14 or above, or military grade 0-5, or above. Also specifically includes all the Program Executive Officers (PEOs), the Deputy PEOs, the PMs and the Deputy PMs for major defense acquisition programs, and the PMs of significant non-major programs.

Concept Exploration and Definition. Beginning at Mission Need Determination, the initial phase of the system acquisition process. During this phase, the acquisition strategy is developed, system alternatives are proposed and examined, and the systems program requirements document is expanded to support subsequent phases.

Configuration Management. Technical and administrative direction and surveillance actions taken to identify and document functional and physical characteristics of an item; to control changes to an item and its characteristics; and to record and report the change processing and implementation status.

Cost/Schedule Control Systems Criteria (C/SCSC). Standards used to evaluate the effectiveness of a contractor's internal systems. The C/SCSC do not require any data to be reported to the Government, but do provide for access to data needed to evaluate the system and monitor its operation during the life of the contract.

Critical Path Method (CPM). A technique that aids dependency of other activities and the time required to complete them. Activities, which when delayed have an impact on the total project schedule, are critical and said to be on the critical path.

Demonstration and Validation (DEM/VAL). Normally the second phase in the acquisition process, following milestone I. Consists of steps necessary to resolve or minimize logistics problems identified during concept exploration, verify preliminary design and engineering, build prototypes, accomplish necessary planning and fully analyze trade off proposals.

DoD Directive 5000.1. "Defense Acquisition". The principal DoD directive on acquisition, it establishes policies, practices and procedures of governing the acquisition of major, non-major, and highly classified sensitive defense acquisition programs.

Engineering & Manufacturing Development (EMD). The third phase in the acquisition process, following Milestone II. The system/equipment and the principal items necessary for its support are fully developed, engineered, designed, fabricated, tested, and evaluated. The intended output is, as a minimum, a pre-production system which closely approximates the final product, the documentation necessary to enter the production phase, and the test results which demonstrate that the production product will meet stated requirements.

Gantt Chart. A graphic portrayal of a project which shows the activities to be completed and the time to complete them is represented by horizontal lines drawn in proportion to the duration of the activity.

Life Cycle Cost (LCC). The total cost to the Government of acquisition and ownership of that system over its useful life. It includes the cost of development, acquisition, support, and, where applicable, disposal.

Mandatory DoD Acquisition Course. A course of study that has been identified by the USD(A) as meeting an established DoD education and training requirement. These courses provide a common, non-component-specific foundation of knowledge for each acquisition function. Each of the following courses is mandatory within one or more career programs or is mandatory to qualify for certain assignments, or both:

a. **Career-development Mandatory Course.** A course that must be taken for an employee to be certified at Level I, II or III within one of the career fields.

b. **Qualification Mandatory Course.** A course that must be completed for an employee to be eligible to perform certain duties or to be given certain assignments.

Milestone. The point when a recommendation is made and approval sought regarding starting or continuing (proceeding to next phase) an acquisition program. Milestone are: 0 (Concept Direction), I (Concept Approval), II (Development Approval), III (Production Approval), and IV (Major Upgrade Decision).

Performance Measurement Baseline. The time-phased budget plan against which contract performance is measured. It is formed by the budgets assigned to scheduled cost accounts and the applicable indirect budgets. It equals the total allocated budget less management reserve.

Procurement. Act of buying goods and services for the Government.

Program Manager (PM). Official responsible for managing a specific acquisition program. Also called a Project Manager or Program Director.

Program Office. An acquisition office with the mission to plan, manage, or execute an acquisition program. [Used interchangeably with System Program Office (SPO)].

Risk Management. All actions taken to identify, assess, and eliminate or reduce risk to an acceptable level in selected areas (e.g., cost, schedule, technical, producibility, etc.); and the total program.

Schedule. Series of things to be done in sequence of events within given period; a timetable.

Standard Time Data. A compilation of all the elements that are used for performing a given class of work with standard elemental time values for each element. The data is used as a basis for determining time standards on work similar to that from which the data was determined without making actual time studies.

Timeline. A schedule line showing key dates and planned events.

Trade-Off. Selection among alternatives to obtain optimum balance for a system. Often the decision is made to opt for less of one parameter (i.e., fully funded) program.

Work Breakdown Structure (WBS). An organized method to break down a project into logical subdivisions or subprojects at lower levels of details. It is very useful in organizing a project.

Appendix B: Survey Instrument

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AERONAUTICAL SYSTEMS CENTER (AFMC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

25 January 1995

MEMORANDUM FOR SURVEY RESPONDENTS

FROM: ASC/CY
Bldg 2041
2511 L Street
Wright-Patterson AFB, OH 45433-7503

SUBJECT: Program Manager Schedule Management Survey Package

1. Effective schedule management is crucial to the success of DoD acquisition programs. It is therefore important to determine which practices are linked to effective program management. You were selected to participate in this research based on your experience, education, and training in the area of DoD program management. Your participation will greatly facilitate our efforts to influence the training and education of program managers.

2. This is not a test and there are no right or wrong answers. It is important that you respond to each statement as thoughtfully and frankly as possible. Pretest of this survey indicates that it will take you approximately 12 minutes to complete it.

3. While participation in this research is voluntary, your contribution is important and will be used as an input to improve training and education programs. No effort will be made to associate you with your response. Nonparticipation will not result in any adverse action. Please return this survey package in the enclosed envelope no later than 10 Mar 1995. For further information, contact Capt Jeff Brown at DSN 785-3473.

Robert C. Helt
Colonel, USAF
Director, Program Management

Attachments:
1. Survey
2. AFIT form 11E
3. Return Envelope

Program Manager Schedule Management Survey

Instructions:

- Use a number 2 pencil
- Please read each question and darken the appropriate circle on the answer sheet provided
- Please ensure answers are marked clearly and do not overlap adjacent circles
- Space for written comments has been provided at the end of the survey
- Your responses will remain anonymous. Please do not put your name on the answer sheet.
- Thank you for your time
- Please return the survey and answer sheet in the enclosed envelope (pouch mail)
- If you have questions please contact Capt Jeff Brown at:

DSN: 785-3473
Commercial: (513) 255-3473

Section 1: Biographical Questions

1. Which of the following have you completed?
   A. Graduate Management Degree
   B. Defense Systems Management College (Program Management Course)
   C. Program Management courses from other institutions
   D. two or more of the above
   E. none of the above

2. In what type of organization do you work?
   A. System Program Office
   B. Laboratory
   C. Headquarters
   D. Other _____

3. In What center do you work?
   A. ASC
   B. ESC
   C. Other _____

4. What is the main product of your organization?
   A. Major Weapon System (ACAT I)
   B. Non-Major Weapon System (ACAT II or below)
   C. Other _____

5. Primarily with which of the following do you generally work?
   A. Concepts (basic research, concept exploration)
   B. Technologies (technology development, concept demonstration)
   C. Developmental Systems (engineering and manufacturing development)
   D. Mature Systems (production, deployment, and support)

6. Which of the following functions are you primarily responsible for:
   A. Project management
   B. Configuration management
   C. Program control
   D. Other _____

7. Which of the following is your primary responsibility:
   A. Planning the acquisition
   B. Specifying the requirements
   C. Evaluating the proposals
   D. Monitoring and controlling the resultant contract
   E. Other _____

8. What is your current grade:
   A. 2 Lt
   B. 1 Lt
   C. Capt
   D. Maj
   E. Lt Col
   F. Col

Section 2: Importance

In this section you will evaluate program manager skills in terms of *importance*. Please note the response scale when answering the questions.

Importance

1	2	3	4	5	6
Not Important	Slightly Important	Important	Very Important	Extremely Important	Don't Know

How important is it for you to:

9. *Define* tasks to be performed to meet the project objectives
10. *Determine* sequence and precedence relationships of project tasks
11. *Develop* a Work Breakdown Structure (WBS) that describes the project work effort
12. *Allocate* scarce resources over the period of the project
13. *Construct* a project network diagram representing tasks and their precedence relationships
14. *Estimate* duration of tasks
15. *Understand* the implications of uncertainty associated with task duration estimates
16. *Use* Program Evaluation and Review Technique (PERT) to estimate project duration
17. *Use* Critical Path Method (CPM) to reduce the project schedule consistent with budgetary constraints
18. *Use* computer simulation to develop and analyze estimates of project duration
19. *Construct* timetables such as Gantt charts
20. *Schedule* distinct, measurable, identifiable milestones
21. *Use* heuristics to develop a schedule that is achievable given existing constraints
22. *Use* statistical analysis methods to characterize uncertainty associated with schedule estimates
23. *Distribute* the cost of work packages across the project schedule to develop a performance measurement baseline (PMB)
24. *Detect* insufficient schedule for work defined
25. *Use* schedule-management software tools
26. *Construct* information briefings to relay schedule status
27. *Perform* trades between cost, schedule, and performance
28. *Understand* the impact of changes in scope on schedule performance
29. *Understand* the concept of earned value and methods for calculating it
30. *Compute* schedule variances
31. *Determine* if schedule variation requires corrective action
32. *Compute* schedule performance index to assess schedule efficiency
33. *Develop* corrective actions to counter unfavorable program variances
34. *Interpret* contractor cost reports (such CPR and CSSR)
35. *Understand* the impact of schedule slippages on performance and cost objectives
36. *Understand* the relationship between contract modifications and the PMB

Section 3: Frequency

In this section you will evaluate your program management skills in terms of *frequency of use*. Please note the new response scale.

Frequency

1	2	3	4	5	6	7
Annually or less	Quarterly	Monthly	Weekly	Don't Use Skill	Don't Have Skill	Don't Know

How frequently are you called upon to:

37. *Define* tasks to be performed to meet the project objectives
38. *Determine* sequence and precedence relationships of project tasks
39. *Develop* a Work Breakdown Structure (WBS) that describes the project work effort
40. *Allocate* scarce resources over the period of the project
41. *Construct* a project network diagram representing tasks and their precedence relationships
42. *Estimate* duration of tasks
43. *Understand* the implications of uncertainty associated with task duration estimates
44. *Use* Program Evaluation and Review Technique (PERT) to estimate project duration
45. *Use* Critical Path Method (CPM) to reduce the project schedule consistent with budgetary constraints
46. *Use* computer simulation to develop and analyze estimates of project duration
47. *Construct* timetables such as Gantt charts
48. *Schedule* distinct, measurable, identifiable milestones
49. *Use* heuristics to develop a schedule that is achievable given existing constraints
50. *Use* statistical analysis methods to characterize uncertainty associated with schedule estimates
51. *Distribute* the cost of work packages across the project schedule to develop a performance measurement baseline (PMB)
52. *Detect* insufficient schedule for work defined
53. *Use* schedule-management software tools
54. *Construct* information briefings to relay schedule status
55. *Perform* trades between cost, schedule, and performance
56. *Understand* the impact of changes in scope on schedule performance
57. *Understand* the concept of earned value and methods for calculating it
58. *Compute* schedule variances
59. *Determine* if schedule variation requires corrective action
60. *Compute* schedule performance index to assess schedule efficiency
61. *Develop* corrective actions to counter unfavorable program variances
62. *Interpret* contractor cost reports (such CPR and CSSR)
63. *Understand* the impact of schedule slippages on performance and cost objectives
64. *Understand* the relationship between contract modifications and the PMB

Comments

Do you feel that any significant schedule-management skills were omitted from this survey?

What single activity related to schedule-management is the most important to you and what activity is most frequently used?

Any other comments?

Appendix C: Response Summary

Competency	Importance		Frequency	
	Median	% 4 or 5	Median	% 3 or 4
1.1	5.0	92.2	4.0	75.3
1.2	4.0	81.9	3.0	70.4
1.3	3.0	44.5	1.0	7.8
2.1	4.0	79.8	4.0	72.4
2.2	3.0	39.9	2.0	21.0
3.1	4.0	57.6	3.0	65.4
3.2	4.0	61.7	3.0	62.1
3.3	3.0	25.5	3.0	16.9
3.4	3.0	38.7	3.0	22.2
3.5	3.0	17.2	4.0	11.9
4.1	3.0	46.5	3.0	52.7
4.2	5.0	82.3	3.0	61.3
4.3	3.0	28.0	3.0	18.1
4.4	2.0	14.0	5.0	8.7
4.5	3.0	27.6	3.0	7.0
4.6	4.0	69.2	3.0	62.1
4.7	3.0	41.5	3.0	46.1
5.1	4.0	60.9	3.0	74.9
5.2	4.0	73.2	3.0	58.0
5.3	5.0	81.1	3.0	69.1
5.4	3.0	45.3	3.0	35.0
5.5	3.0	34.2	3.0	36.6
5.6	4.0	66.7	3.0	60.5
5.7	3.0	24.7	5.0	23.8
5.8	4.0	74.8	3.0	58.4
5.9	4.0	54.8	3.0	48.2
5.10	4.0	79.9	3.0	67.4
5.11	4.0	56.4	3.0	36.2

Appendix D: Ranked Data

Importance	
Competency	% 4 or 5
1.1	92.2
4.2	82.3
1.2	81.9
5.3	81.1
5.1	79.9
2.1	79.8
5.8	74.8
5.2	73.2
4.6	69.2
5.6	66.7
3.2	61.7
5.1	60.9
3.1	57.6
5.11	56.4
5.9	54.8
4.1	46.5
5.4	45.3
1.3	44.5
4.7	41.5
2.2	39.9
3.4	38.7
5.5	34.2
4.3	28.0
4.5	27.6
3.3	25.5
5.7	24.7
3.5	17.2
4.4	14.0

Frequency	
Competency	% 3 or 4
1.1	75.3
5.1	74.9
2.1	72.4
1.2	70.4
5.3	69.1
5.1	67.4
3.1	65.4
4.6	62.1
3.2	62.1
4.2	61.3
5.6	60.5
5.8	58.4
5.2	58.0
4.1	52.7
5.9	48.2
4.7	46.1
5.5	36.6
5.11	36.2
5.4	35.0
5.7	23.8
3.4	22.2
2.2	21.0
4.3	18.1
3.3	16.9
3.5	11.9
4.4	8.7
1.3	7.8
4.5	7.0

Appendix E: Decision Rule Application to Total Sample

Competency	Importance Question	Median	Frequency Question	Median
1.1	9	5.0	37	4.0
1.2	10	4.0	38	3.0
1.3	11	3.0	39	**1.0**
2.1	12	4.0	40	4.0
2.2	13	3.0	41	**2.0**
3.1	14	4.0	42	3.0
3.2	15	4.0	43	3.0
3.3	16	3.0	44	3.0
3.4	17	3.0	45	3.0
3.5	18	3.0	46	4.0
4.1	19	3.0	47	3.0
4.2	20	5.0	48	3.0
4.3	21	3.0	49	3.0
4.4	22	**2.0**	50	5.0
4.5	23	3.0	51	3.0
4.6	24	4.0	52	3.0
4.7	25	3.0	53	3.0
5.1	26	4.0	54	3.0
5.2	27	4.0	55	3.0
5.3	28	5.0	56	3.0
5.4	29	3.0	57	3.0
5.5	30	3.0	58	3.0
5.6	31	4.0	59	3.0
5.7	32	3.0	60	5.0
5.8	33	4.0	61	3.0
5.9	34	4.0	62	3.0
5.1	35	4.0	63	3.0
5.11	36	4.0	64	3.0

Appendix F: Kruskal-Wallis Results

Competency	Management Education		Organization Type		Acquisition Phase		Program Activity		Grade Level	
	Importance P-Value	Frequency P-Value	Importance P-Value	Frequency P-Value	Importance P-Value	Frequency P-Value	Importance P-Value	Frequency P-Value	Importance P-Value	Frequency P-Value
1.1	**0.0405**	0.8342	0.6501	0.3209	0.5880	0.1516	0.9449	0.1343	0.2862	0.1322
1.2	0.4151	0.8432	0.2351	0.6505	0.7783	0.2153	0.1267	0.2768	0.6834	0.7276
1.3	0.9039	0.2626	0.3339	0.0936	0.9458	0.3282	0.8169	0.0690	0.0580	0.6180
2.1	0.1018	0.2439	0.8537	0.7733	0.7056	0.0584	0.7598	0.7715	**0.0087**	**0.0164**
2.2	0.1779	0.1455	0.1574	0.3887	0.5119	0.2406	0.8544	0.0562	0.1141	0.3449
3.1	0.5075	0.1692	0.2229	0.2579	0.6482	**0.0163**	0.1318	0.0962	0.4857	0.3560
3.2	0.6952	**0.0014**	0.8607	0.7064	0.6367	0.1385	0.7338	0.0608	0.4966	0.1763
3.3	0.0804	0.5071	0.4244	0.5799	0.9987	0.6350	0.7638	**0.0163**	0.8069	0.5888
3.4	0.0978	0.4160	0.1261	0.3522	0.5725	0.5653	0.9749	0.1841	0.6147	0.1986
3.5	0.0883	0.6193	0.4587	0.3021	0.2634	0.1015	0.9738	**0.0008**	0.9381	0.5756
4.1	0.6214	0.7308	0.6027	0.9604	0.4734	0.0544	0.3346	0.2264	0.2388	0.6501
4.2	0.1678	0.1282	**0.0246**	0.6087	0.1847	**0.0396**	0.6122	0.8067	0.2831	0.4996
4.3	0.1356	0.2857	0.8841	0.2161	0.8027	0.1997	0.1709	**0.0231**	0.3072	0.1531
4.4	0.1650	0.2305	0.7302	0.0769	0.1404	0.3121	0.1257	0.1106	0.1420	0.4003
4.5	0.4994	0.0543	0.7423	0.1736	0.4863	0.2018	**0.0373**	0.0863	0.0738	0.2381
4.6	0.8284	0.0718	0.5470	0.9419	0.3322	0.0794	0.5628	0.5236	0.1967	**0.0352**
4.7	0.2138	**0.0074**	0.6944	0.5988	0.7524	0.0809	0.8828	0.3722	0.1598	0.1929
5.1	0.6206	0.2777	0.0889	0.7334	0.2269	0.3422	0.6312	0.6862	0.1886	**0.0346**
5.2	0.4163	0.3127	0.1851	0.4695	**0.0268**	0.1574	0.7523	0.0817	0.0894	0.3630
5.3	0.9212	0.4360	0.2703	0.1579	0.1543	**0.0341**	0.3435	0.4461	0.4295	0.1781
5.4	0.9224	0.5113	0.3071	0.0685	0.2981	**0.0055**	0.1579	0.1142	**0.0440**	0.6406
5.5	0.8050	0.4588	0.1304	0.1532	0.6496	0.2142	0.1722	**0.0276**	**0.0356**	0.2564
5.6	0.2149	0.1222	0.3862	0.4084	0.0741	0.1068	0.0742	0.1574	0.2759	0.3818
5.7	0.5347	0.1162	0.3280	0.3755	0.7019	0.2818	**0.0149**	0.1158	**0.0286**	0.1003
5.8	0.1389	0.8989	0.1283	0.2355	0.3353	0.6216	0.3720	0.4505	0.2985	0.3999
5.9	0.8142	**0.0087**	0.2735	**0.0087**	0.5293	**0.0353**	0.4114	0.1158	0.2525	0.4553
5.10	0.5690	0.7588	0.0650	0.8633	0.1774	**0.0355**	0.4925	0.6871	0.1327	0.1407
5.11	0.7641	**0.0387**	0.1892	0.1198	0.3886	**0.0027**	0.2093	**0.0063**	0.1728	0.5606

Appendix G: Descriptive Statistics

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
LOWER 95.0%	3.188	1.235	1.261	1.592	2.955	1.275	2.702	4.512	4.562	4.076	3.188	4.191	3.098
MEAN	3	1	1	2	3	1	3	5	5	4	3	4	3
UPPER 95.0%	3.479	1.473	1.389	1.783	3.16	1.531	3.117	4.747	4.722	4.261	3.471	4.41	3.379
S.D.	1.2	0.9	0.5	0.8	0.8	1.0	1.6	0.9	0.6	0.7	1.1	0.9	1.1
S.E. (MEAN)	0.07	0.06	0.03	0.05	0.05	0.07	0.11	0.06	0.04	0.05	0.07	0.06	0.07

	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
LOWER 95.0%	3.531	3.66	2.739	3.019	2.547	3.22	4.192	2.951	2.433	2.861	3.916	3.142	3.661
MEAN	4	4	3	3	3	3	4	3	3	3	4	3	4
UPPER 95.0%	3.753	3.895	3.031	3.318	2.868	3.513	4.425	3.279	2.736	3.197	4.158	3.434	3.928
S.D.	0.9	0.9	1.2	1.2	1.3	1.2	0.9	1.3	1.2	1.3	1.0	1.2	1.1
S.E. (MEAN)	0.06	0.06	0.07	0.08	0.08	0.07	0.06	0.08	0.08	0.09	0.06	0.07	0.07

	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39
LOWER 95.0%	4.004	4.207	3.319	3	3.752	2.811	3.915	3.392	4.056	3.521	3.197	3.031	2.108
MEAN	4	4	3	3	4	3	4	4	4	4	3	3	2
UPPER 95.0%	4.26	4.419	3.627	3.279	4.026	3.123	4.184	3.702	4.298	3.82	3.453	3.306	2.559
S.D.	1.0	0.8	1.2	1.1	1.1	1.2	1.1	1.2	1.0	1.2	1.0	1.1	1.8
S.E. (MEAN)	0.06	0.05	0.08	0.07	0.07	0.08	0.07	0.08	0.06	0.08	0.06	0.07	0.11

	Q40	Q41	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50	Q51	Q52
LOWER 95.0%	3.164	2.596	3.036	3.103	2.879	2.817	3.263	3.02	2.832	3.272	3.309	3.074	3.047
MEAN	3	3	3	3	3	3	4	3	3	4	4	3	3
UPPER 95.0%	3.445	3.026	3.326	3.424	3.335	3.249	3.766	3.366	3.118	3.757	3.819	3.593	3.372
S.D.	1.1	1.7	1.2	1.3	1.8	1.7	2.0	1.4	1.1	1.9	2.0	2.1	1.3
S.E. (MEAN)	0.07	0.11	0.07	0.08	0.12	0.11	0.13	0.09	0.07	0.12	0.13	0.13	0.08

	Q53	Q54	Q55	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64
LOWER 95.0%	3.346	3.118	3.056	3.211	3.163	3.241	3.11	3.584	2.987	3.001	3.194	2.921
MEAN	4	3	3	3	3	3	3	4	3	3	3	3
UPPER 95.0%	3.723	3.351	3.372	3.497	3.586	3.656	3.424	4.03	3.301	3.37	3.481	3.35
S.D.	1.5	0.9	1.3	1.1	1.7	1.6	1.2	1.8	1.2	1.5	1.1	1.7
S.E. (MEAN)	0.10	0.06	0.08	0.07	0.11	0.11	0.08	0.11	0.08	0.09	0.07	0.11

Appendix H: Summary Statistics

	Importance					Frequency				Decision Rule	
Competency	Median	% 3-5	% 2-5	Don't Know	Value	Median	% 1-4	Don't Know	Value	Difference	Value
1.1	5.0	99.2	99.6	0.4	X	4.0	97.1	0.4	X	2.5	X
1.2	4.0	99.2	100.0	0.0	X	3.0	95.1	0.8	X	4.9	X
1.3	3.0	75.4	93.5	1.2	X	1.0	74.9	0.4	X	**18.6**	X
2.1	4.0	95.0	97.5	2.1	X	4.0	95.0	1.6	X	2.5	X
2.2	3.0	70.8	95.9	0.4	X	2.0	74.9	1.2	X	**21.0**	X
3.1	4.0	91.3	98.3	0.4	X	3.0	91.7	0.8	X	6.6	X
3.2	4.0	92.6	98.8	0.0	X	3.0	89.7	1.2	X	9.1	X
3.3	3.0	58.0	87.2	2.5	X	3.0	62.5	1.2	X	**24.7**	X
3.4	3.0	72.0	88.5	1.2	X	3.0	69.1	0.8	X	**19.4**	X
3.5	3.0	48.9	78.5	4.1		4.0	51.8	1.6	X	**26.7**	
4.1	3.0	77.0	93.0	0.4	X	3.0	80.7	0.4	X	12.3	X
4.2	5.0	94.6	97.5	0.8	X	3.0	95.5	0.8	X	2.0	X
4.3	3.0	61.7	84.7	5.3	X	3.0	57.6	4.5	X	**27.1**	X
4.4	2.0	43.2	79.4	3.7		5.0	49.0	2.5		**30.4**	
4.5	3.0	59.7	82.3	4.5	X	3.0	53.0	3.3	X	**29.3**	X
4.6	4.0	92.2	97.5	2.1	X	3.0	89.7	2.5	X	7.8	X
4.7	3.0	74.4	90.4	2.1	X	3.0	72.1	0.0	X	**18.3**	X
5.1	4.0	87.6	97.9	0.4	X	3.0	94.6	1.6	X	3.3	X
5.2	4.0	93.4	97.5	0.0	X	3.0	88.1	0.8	X	9.4	X
5.3	5.0	97.1	98.7	0.4	X	3.0	90.9	1.2	X	7.8	X
5.4	3.0	76.6	89.8	0.8	X	3.0	67.5	1.6	X	**22.3**	X
5.5	3.0	71.2	92.2	3.7	X	3.0	64.1	2.9	X	**28.1**	X
5.6	4.0	88.1	95.5	1.2	X	3.0	83.5	2.1	X	12.0	X
5.7	3.0	62.1	83.1	1.2	X	5.0	49.3	1.2		**33.8**	
5.8	4.0	90.0	94.1	4.1	X	3.0	87.2	2.9	X	6.9	X
5.9	4.0	79.8	90.5	1.6	X	3.0	75.3	0.8	X	**15.2**	X
5.10	4.0	95.1	97.2	1.2	X	3.0	90.4	1.6	X	6.8	X
5.11	4.0	82.7	91.3	2.5	X	3.0	77.3	4.9	X	14.0	X

Appendix I: Competency Groups

Competency	Importance % 3-5	Frequency % 1-4	Combined %
1.1	99.2	97.1	98.2
1.2	99.2	95.1	97.2
4.2	94.6	95.5	95.1
2.1	95.0	95.0	95.0
5.3	97.1	90.9	94.0
5.1	95.1	90.4	92.8
3.10	91.3	91.7	91.5
3.2	92.6	89.7	91.2
5.1	87.6	94.6	91.1
4.6	92.2	89.7	91.0
5.2	93.4	88.1	90.8
5.8	90.0	87.2	88.6
5.6	88.1	83.5	85.8
5.11	82.7	77.3	80.0
4.1	77.0	80.7	78.9
5.9	79.8	75.3	77.6
1.3	75.4	74.9	75.2
4.7	74.4	72.1	73.3
2.2	70.8	74.9	72.9
5.4	76.6	67.5	72.1
3.4	72.0	69.1	70.6
5.5	71.2	64.1	67.7
3.3	58.0	62.5	60.3
4.3	61.7	57.6	59.7
4.5	59.7	53.0	56.4
5.7	62.1	49.3	55.7
3.5	48.9	51.8	50.4
4.4	43.2	49.0	46.1

Appendix J: Don't Know Percentages

Competency	Importance %
4.3	5.3
4.5	4.5
3.5	4.1
5.7	4.1
4.4	3.7
5.4	3.7
3.3	2.5
5.11	2.5
2.1	2.1
4.6	2.1
4.7	2.1
5.8	1.6
1.3	1.2
3.4	1.2
5.5	1.2
5.6	1.2
5.9	1.2
4.2	0.8
5.3	0.8
1.1	0.4
2.2	0.4
3.1	0.4
4.1	0.4
5.1	0.4
5.2	0.4
1.2	0.0
3.2	0.0
5.1	0.0

Competency	Frequency %
5.11	4.9
4.3	4.5
4.5	3.3
5.4	2.9
5.7	2.9
4.4	2.5
4.6	2.5
5.5	2.1
2.1	1.6
3.5	1.6
5.3	1.6
5.9	1.6
5.1	1.6
2.2	1.2
3.2	1.2
3.3	1.2
5.2	1.2
5.6	1.2
1.2	0.8
3.1	0.8
3.4	0.8
4.2	0.8
5.1	0.8
5.8	0.8
1.1	0.4
1.3	0.4
4.1	0.4
4.7	0.0

Appendix K: Responses Based on Acquisition Phase

Competency Importance Based on Acquisition Phase	Importance (Concepts)	Importance (Tech Demo)	Importance (Develop)	Importance (Mature)
1.*Define* tasks to meet project objectives	5	5	5	5
2.*Determine* sequence and precedence relationships of project tasks	4	4	4	4
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	3	3	3	3
4.*Allocate* scarce resources *over the period of the project*	4	5	4	5
5.*Construct* a project network diagram representing tasks and their precedence relationships	3	3	3	3
6.*Estimate* duration of tasks	4	4	4	4
7.*Understand* the implications of uncertainty associated with task duration estimates	4	4	4	4
8.*Use* PERT to estimate project duration	3	3	3	3
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	3	3	3	3
10.*Use* computer simulation to develop and analyze estimates of project duration	3	3	3	2
11.*Construct* timetables such as Gantt charts	3	3	3	3
12.*Schedule* distinct, measurable, identifiable milestones	4	5	5	4
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	3	3	3	3
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	2	3	3	2
15.*Distribute* the cost of work packages across the project schedule to develop PMB	2	3	3	3
16.*Detect* insufficient schedule for work defined	4	4	4	4
17.*Use* schedule-management software tools	3	3	3	3
18.*Construct* information briefings	3	4	4	4
19.*Perform* cost, schedule, and performance trades	4	4	5	4
20.*Understand* the impact of changes in scope on schedule performance	4	4	5	4
21.*Understand* the concept of earned value	3	3	4	3
22.*Compute* schedule variances	3	3	3	3
23.*Determine* if schedule variation requires corrective action	3	4	4	4
24.*Compute* SPI to assess schedule efficiency	3	3	3	3
25.*Develop* corrective actions to counter unfavorable program variances	4	4	4	4
26.*Interpret* contractor cost reports	3	4	4	4
27.*Understand* the impact of schedule slippages on performance and cost objectives	4	4	5	4
28.*Understand* the relationship between contract modifications and the PMB	4	4	4	4

Importance Scale: 0 = don't know, 1 = not, 2 = slightly, 3 = important, 4 = very important, 5 = extremely important.

Competency Usage Based on Acquisition Phase	Frequency (Concepts)	Frequency (Tech Demo)	Frequency (Develop)	Frequency (Mature)
1.*Define* tasks to be performed to meet project objectives	4	4	4	4
2.*Determine* sequence and precedence relationships of project tasks	4	3	3	3
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	2	1	1	1
4.Allocate scarce resources *over the period of the project*	4	3	4	4
5.Construct a project network diagram representing tasks and their precedence relationships	3	2	2	2
6.*Estimate* duration of tasks	3	3	3	4
7.*Understand* the implications of uncertainty associated with task duration estimates	4	3	3	4
8.*Use* PERT to estimate project duration	0	3	3	3
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	4	2	3	3
10.*Use* computer simulation to develop and analyze estimates of project duration	0	3	4	0
11.*Construct* timetables such as Gantt charts	4	3	3	3
12.*Schedule* distinct, measurable, identifiable milestones	3	2	3	3
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	0	3	4	0
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	0	2	0	0
15.*Distribute* the cost of work packages across the project schedule to develop PMB	0	2	3	0
16.*Detect* insufficient schedule for work defined	3	3	3	3
17.*Use* schedule-management software tools	0	4	3	4
18.*Construct* information briefings	3	3	3	3
19.*Perform* cost, schedule, and performance trades	4	3	3	3
20.*Understand* the impact of changes in scope on schedule performance	4	3	3	4
21.*Understand* the concept of earned value	0	3	3	4
22.*Compute* schedule variances	0	3	3	3
23.*Determine* if schedule variation requires corrective action	0	3	3	3
24.*Compute* SPI to assess schedule efficiency	0	4	3	3
25.*Develop* corrective actions to counter unfavorable program variances	3	3	3	3
26.*Interpret* contractor cost reports	0	3	3	3
27.*Understand* the impact of schedule slippages on performance and cost objectives	0	3	3	4
28.*Understand* the relationship between contract modifications and the PMB	0	3	3	3

Frequency Scale: 0 = don't use/ have/know about skill, 1 = annualy or less, 2 = quarterly, 3 = monthly, 4 = weekly.

Competency Value Based on Acquisition Phase	Value (Concepts)	Value (Tech Demo)	Value (Develop)	Value (Mature)
1.*Define* tasks to be performed to meet project objectives	9	9	9	9
2.*Determine* sequence and precedence relationships of project tasks	8	7	7	7
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	5	4	4	4
4.*Allocate* scarce resources *over the period of the project*	8	8	8	9
5.*Construct* a project network diagram representing tasks and their precedence relationships	6	5	5	5
6.*Estimate* duration of tasks	7	7	7	8
7.*Understand* the implications of uncertainty associated with task duration estimates	8	7	7	8
8.*Use* PERT to estimate project duration	3	6	6	6
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	7	5	6	6
10.*Use* computer simulation to develop and analyze estimates of project duration	3	6	7	2
11.*Construct* timetables such as Gantt charts	7	6	6	6
12.*Schedule* distinct, measurable, identifiable milestones	7	7	8	7
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	3	6	7	3
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	2	5	3	2
15.*Distribute* the cost of work packages across the project schedule to develop PMB	2	5	6	3
16.*Detect* insufficient schedule for work defined	7	7	7	7
17.*Use* schedule-management software tools	3	7	6	7
18.*Construct* information briefings	6	7	7	7
19.*Perform* cost, schedule, and performance trades	8	7	8	7
20.*Understand* the impact of changes in scope on schedule performance	8	7	8	8
21.*Understand* the concept of earned value	3	6	7	7
22.*Compute* schedule variances	3	6	6	6
23.*Determine* if schedule variation requires corrective action	3	7	7	7
24.*Compute* SPI to assess schedule efficiency	3	7	6	6
25.*Develop* corrective actions to counter unfavorable program variances	7	7	7	7
26.*Interpret* contractor cost reports	3	7	7	7
27.*Understand* the impact of schedule slippages on performance and cost objectives	4	7	8	8
28.*Understand* the relationship between contract modifications and the PMB	4	7	7	7

Decision Rule: Value = Frequency plus importance. Valuable = 5 or greater

Appendix L: Responses Based on Primary Responsibility

Competency Importance Based on Primary Responsibility	Importance (Planning)	Importance (Specifying)	Importance (Evaluating)	Importance (Monitoring)
1.*Define* tasks to meet project objectives	5	5	5	5
2.*Determine* sequence and precedence relationships of project tasks	4	4	4	4
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	3	3	3	3
4.Allocate scarce resources *over the period of the project*	5	4	4	4
5.*Construct* a project network diagram representing tasks and their precedence relationships	3	3	3	3
6.*Estimate* duration of tasks	4	3	3	4
7.*Understand* the implications of uncertainty associated with task duration estimates	4	4	4	4
8.*Use* PERT to estimate project duration	3	2	3	3
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	3	3	3	3
10.*Use* computer simulation to develop and analyze estimates of project duration	3	2	2	3
11.*Construct* timetables such as Gantt charts	3	3	4	4
12.*Schedule* distinct, measurable, identifiable milestones	5	4	4	5
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	3	2	3	3
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	2	2	3	3
15.*Distribute* the cost of work packages across the project schedule to develop PMB	3	2	3	3
16.*Detect* insufficient schedule for work defined	4	4	4	4
17.*Use* schedule-management software tools	3	3	3	4
18.*Construct* information briefings	4	4	4	4
19.*Perform* cost, schedule, and performance trades	5	4	4	4
20.*Understand* the impact of changes in scope on schedule performance	4	4	5	5
21.*Understand* the concept of earned value	3	3	4	4
22.*Compute* schedule variances	3	3	4	3
23.*Determine* if schedule variation requires corrective action	4	3	4	4
24.*Compute* SPI to assess schedule efficiency	3	2	3	3
25.*Develop* corrective actions to counter unfavorable program variances	4	4	4	4
26.*Interpret* contractor cost reports	4	4	4	4
27.*Understand* the impact of schedule slippages on performance and cost objectives	4	4	5	4
28.*Understand* the relationship between contract modifications and the PMB	4	3	4	4

Importance Scale: 0 = don't know, 1 = not, 2 = slightly, 3 = important, 4 = very important, 5 = extremely important.

Competency Useage Based on Primary Responsibility	Frequency (Planning)	Frequency (Specifying)	Frequency (Evaluating)	Frequency (Monitoring)
1.*Define* tasks to be performed to meet project objectives	4	3	4	4
2.*Determine* sequence and precedence relationships of project tasks	3	3	4	3
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	1	2	3	1
4.*Allocate* scarce resources *over the period of the project*	4	3	3	4
5.*Construct* a project network diagram representing tasks and their precedence relationships	2	0	2	2
6.*Estimate* duration of tasks	3	3	4	3
7.*Understand* the implications of uncertainty associated with task duration estimates	4	3	3	4
8.*Use* PERT to estimate project duration	0	3	3	3
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	4	2	3	3
10.*Use* computer simulation to develop and analyze estimates of project duration	0	3	4	0
11.*Construct* timetables such as Gantt charts	4	3	3	3
12.*Schedule* distinct, measurable, identifiable milestones	3	3	3	3
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	3	0	0	3
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	4	0	0	3
15.*Distribute* the cost of work packages across the project schedule to develop PMB	3	0	2	3
16.*Detect* insufficient schedule for work defined	3	3	3	3
17.*Use* schedule-management software tools	3	3	4	3
18.*Construct* information briefings	3	3	3	3
19.*Perform* cost, schedule, and performance trades	3	2	3	3
20.*Understand* the impact of changes in scope on schedule performance	3	3	4	3
21.*Understand* the concept of earned value	3	3	4	3
22.*Compute* schedule variances	3	3	3	3
23.*Determine* if schedule variation requires corrective action	3	2	3	3
24.*Compute* SPI to assess schedule efficiency	3	0	0	3
25.*Develop* corrective actions to counter unfavorable program variances	3	3	4	3
26.*Interpret* contractor cost reports	3	3	3	3
27.*Understand* the impact of schedule slippages on performance and cost objectives	3	3	3	3
28.*Understand* the relationship between contract modifications and the PMB	3	3	3	3

Frequency Scale: 0 = don't use/ have/know about skill, 1 = annualy or less, 2 = quarterly, 3 = monthly, 4 = weekly.

Competency Useage Based on Primary Responsibility	Value (Planning)	Value (Specifying)	Value (Evaluating)	Value (Monitoring)
1.*Define* tasks to be performed to meet project objectives	9	8	9	9
2.*Determine* sequence and precedence relationships of project tasks	7	7	8	7
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	4	5	6	4
4.*Allocate* scarce resources *over the period of the project*	9	7	7	8
5.*Construct* a project network diagram representing tasks and their precedence relationships	5	3	5	5
6.*Estimate* duration of tasks	7	6	7	7
7.*Understand* the implications of uncertainty associated with task duration estimates	8	7	7	8
8.*Use* PERT to estimate project duration	3	5	6	6
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	7	5	6	6
10.*Use* computer simulation to develop and analyze estimates of project duration	3	5	6	3
11.*Construct* timetables such as Gantt charts	7	6	7	7
12.*Schedule* distinct, measurable, identifiable milestones	8	7	7	8
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	6	2	3	6
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	6	2	3	6
15.*Distribute* the cost of work packages across the project schedule to develop PMB	6	2	5	6
16.*Detect* insufficient schedule for work defined	7	7	7	7
17.*Use* schedule-management software tools	6	6	7	7
18.*Construct* information briefings	7	7	7	7
19.*Perform* cost, schedule, and performance trades	8	6	7	7
20.*Understand* the impact of changes in scope on schedule performance	7	7	9	8
21.*Understand* the concept of earned value	6	6	8	7
22.*Compute* schedule variances	6	6	7	6
23.*Determine* if schedule variation requires corrective action	7	5	7	7
24.*Compute* SPI to assess schedule efficiency	6	2	3	6
25.*Develop* corrective actions to counter unfavorable program variances	7	7	8	7
26.*Interpret* contractor cost reports	7	7	7	7
27.*Understand* the impact of schedule slippages on performance and cost objectives	7	7	8	7
28.*Understand* the relationship between contract modifications and the PMB	7	6	7	7

Decision Rule: Value = Frequency plus importance. Valuable = 5 or greater

Appendix M: Responses Based on Grade

Competency Importance Based on Grade	Importance (2Lt - Capt)	Importance (Maj)	Importance (LtCol)	Importance (Col)
1.*Define* tasks to meet project objectives	5	5	5	5
2.*Determine* sequence and precedence relationships of project tasks	4	4	4	4
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	3	4	3	4
4.*Allocate* scarce resources *over the period of the project*	4	4	4	5
5.*Construct* a project network diagram representing tasks and their precedence relationships	3	3	3	4
6.*Estimate* duration of tasks	4	4	4	4
7.*Understand* the implications of uncertainty associated with task duration estimates	4	4	4	4
8.*Use* PERT to estimate project duration	3	3	3	3
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	3	3	3	3
10.*Use* computer simulation to develop and analyze estimates of project duration	3	3	3	3
11.*Construct* timetables such as Gantt charts	4	3	3	4
12.*Schedule* distinct, measurable, identifiable milestones	4	4	5	5
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	3	3	3	3
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	2	3	2	3
15.*Distribute* the cost of work packages across the project schedule to develop PMB	3	3	3	3
16.*Detect* insufficient schedule for work defined	4	4	4	5
17.*Use* schedule-management software tools	3	3	3	4
18.*Construct* information briefings	3	4	4	4
19.*Perform* cost, schedule, and performance trades	4	4	4	4
20.*Understand* the impact of changes in scope on schedule performance	4	4	5	5
21.*Understand* the concept of earned value	3	3	3	4
22.*Compute* schedule variances	3	3	3	3
23.*Determine* if schedule variation requires corrective action	4	4	4	4
24.*Compute* SPI to assess schedule efficiency	3	3	3	3
25.*Develop* corrective actions to counter unfavorable program variances	4	4	4	5
26.*Interpret* contractor cost reports	3	4	4	4
27.*Understand* the impact of schedule slippages on performance and cost objectives	4	5	4	5
28.*Understand* the relationship between contract modifications and the PMB	4	4	4	4

Importance Scale: 0 = don't know, 1 = not, 2 = slightly, 3 = important, 4 = very important, 5 = extremely important.

Competencies Used Based on Grade	Frequency (2Lt - Capt)	Frequency (Maj)	Frequency (LtCol)	Frequency (Col)
1.*Define* tasks to be performed to meet project objectives	3	4	4	4
2.*Determine* sequence and precedence relationships of project tasks	3	3	3	3
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	1	2	1	1
4.Allocate scarce resources *over the period of the project*	2	4	4	4
5.Construct a project network diagram representing tasks and their precedence relationships	2	2	2	3
6.*Estimate* duration of tasks	3	3	3	3
7.*Understand* the implications of uncertainty associated with task duration estimates	3	3	3	4
8.*Use* PERT to estimate project duration	2	3	3	4
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	3	3	3	4
10.*Use* computer simulation to develop and analyze estimates of project duration	2	4	4	0
11.*Construct* timetables such as Gantt charts	3	3	3	3
12.*Schedule* distinct, measurable, identifiable milestones	3	3	3	3
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	2	3	4	4
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	2	4	0	0
15.*Distribute* the cost of work packages across the project schedule to develop PMB	4	2	3	0
16.*Detect* insufficient schedule for work defined	3	3	3	4
17.*Use* schedule-management software tools	3	3	3	4
18.*Construct* information briefings	3	3	3	4
19.*Perform* cost, schedule, and performance trades	3	4	3	4
20.*Understand* the impact of changes in scope on schedule performance	3	3	3	4
21.*Understand* the concept of earned value	4	3	3	3
22.*Compute* schedule variances	3	3	3	0
23.*Determine* if schedule variation requires corrective action	3	3	3	3
24.*Compute* SPI to assess schedule efficiency	3	3	3	0
25.*Develop* corrective actions to counter unfavorable program variances	3	3	3	3
26.*Interpret* contractor cost reports	3	3	3	3
27.*Understand* the impact of schedule slippages on performance and cost objectives	3	3	3	4
28.*Understand* the relationship between contract modifications and the PMB	2	3	3	3

Frequency Scale: 0 = don't use/ have/know about skill, 1 = annualy or less, 2 = quarterly, 3 = monthly, 4 = weekly.

Competencies Valued Based on Grade	Value (2Lt - Capt)	Value (Maj)	Value (LtCol)	Value (Col)
1.*Define* tasks to be performed to meet project objectives	8	9	9	9
2.*Determine* sequence and precedence relationships of project tasks	7	7	7	7
3.*Develop* a Work Breakdown Structure (WBS) that describes the project work effort	4	6	4	5
4.*Allocate* scarce resources *over the period of the project*	6	8	8	9
5.*Construct* a project network diagram representing tasks and their precedence relationships	5	5	5	7
6.*Estimate* duration of tasks	7	7	7	7
7.*Understand* the implications of uncertainty associated with task duration estimates	7	7	7	8
8.*Use* PERT to estimate project duration	5	6	6	7
9.*Use* CPM to reduce the project schedule consistent with budgetary constraints	6	6	6	7
10.*Use* computer simulation to develop and analyze estimates of project duration	5	7	7	3
11.*Construct* timetables such as Gantt charts	7	6	6	7
12.*Schedule* distinct, measurable, identifiable milestones	7	7	8	8
13.*Use* heuristics to develop a schedule that is achievable given existing constraints	5	6	7	7
14.*Use* statistical analysis methods to characterize uncertainty associated with schedule estimates	4	7	2	3
15.*Distribute* the cost of work packages across the project schedule to develop PMB	7	5	6	3
16.*Detect* insufficient schedule for work defined	7	7	7	9
17.*Use* schedule-management software tools	6	6	6	8
18.*Construct* information briefings	6	7	7	8
19.*Perform* cost, schedule, and performance trades	7	8	7	8
20.*Understand* the impact of changes in scope on schedule performance	7	7	8	9
21.*Understand* the concept of earned value	7	6	6	7
22.*Compute* schedule variances	6	6	6	3
23.*Determine* if schedule variation requires corrective action	7	7	7	7
24.*Compute* SPI to assess schedule efficiency	6	6	6	3
25.*Develop* corrective actions to counter unfavorable program variances	7	7	7	8
26.*Interpret* contractor cost reports	6	7	7	7
27.*Understand* the impact of schedule slippages on performance and cost objectives	7	8	7	9
28.*Understand* the relationship between contract modifications and the PMB	6	7	7	7

Decision Rule: Value = Frequency plus importance. Valuable = 5 or greater

Appendix N: Open Comments

Omitted Competencies

1. "source of info used for management (gannt vs PERT vs C/SSR vs Tier II, etc.)"
2. "discussion of IPTs in PM"
3. "financial management and award fee administration"
4. "metrics"
5. "PMD, COEA, Aquisition strategy"
6. "change manegement"
7. "dynamic personnel exercises"
8. "no"
9. "how you relate schedule performance to award fee determination"
10. "matching workload of people on the team to priorities at any given time"
11. "Motivational skills and personnel management skills necessary to drive the contractor/government team to a common achievable goal."
12. "yes"
13. "Resources: How we handle no resource problems of current draw down. Allocation assumes we have something to start with."
14. "Doesn't address validity of models and baseline development tools for early product lifecycles. Danger of great precision with poor accuracy."
15. "no!"
16. "Communication skills - being able to tell people what needs to be done."
17. "People management skills, team leadership skills, personal time management"
18. "The impact of leadership on schedule management"
19. "motivational techniques that get more out of people"
20. "TQM processes that influence schedule"
21. "effect work performance and input"
22. "no"
23. "can accelerate or improve schedule performance (org structure, processes)"
24. "Nothing on line of balance, schedule integration."
25. "Ability to integrate & process schedule information from different levels of a project."
26. "Determining what type of schedule imformation to request from contractors."
27. "ability to work with the user in defining and understanding requirements"
28. "people mgt - disputes/disagreements (govt <-> contrctr), coordination within govt (SPO, user, HQ AFMC, User's HQ, Logisitics, other SPOs"
29. "A lot of these skill I have others do for me"
30. "common sense & operational experience! We are too dependent upon statistical methods and spend too much time generating worthless metrics and filling out surveys. We could cut out work force more effectively if we got rid of all the unecessary folks who generate this kind of eyewash."
31. "the ability to stay in close contact and close communication with the contractor to know what is really happening with the program. By the time events are recorded in reports and briefed, its too late to fix within cost and schedule"
32. "the questions don't address the distinction between contractor and SPO. The SPO writes a WBS to construct a SOW. The contractor writes one to execute and make a product. We must understand our roles and relationships."
33. "no!"
34. "personnel management"
35. "rate (cost/hr) for allocated resources"
36. "Peer/greybeard review or comparing the schedule with past performance or similar projects to obtain "gut" or reasonableness check"

37. "planning emphasis on project cost reduction @ front end of life cycle"
38. "integrating activities with others, balancing the application of these techniques with the delegation of these techniques."
39. "no"
40. "Types of software such as use of Microsoft Project"
41. "integrated master plan development & usage; integrated master schedule development & usage; how, and if, contractor tools are used; what tools are used PS5XL, PS6XL, schedular, etc."
42. "no!"
43. "no"
44. "team buy-in"
45. "no"
46. "no"
47. "time in career field"
48. "no!"
49. "We have computerized schedule building tools; don't use the CSSR methods currently not required for sustainment type work."
50. "understanding & estimating abilities of individuals assigned tasks"
51. "believe the process and discipline of requirements handling - from top thru derived; a QFD type process"
52. "no"
53. "communication patterns - (talk one-on-one, meetings), phone, FAX, E-mail, video conf, travel how often? with whom? (user, developer, air staff)"
54. "no"
55. "You seem to be on this road like we are doing programs: companies do work; we watch. Don't forget that!"
56. "How important is your experience level support your skills? How frequently do you depend on your previous experience to manage schedules?"
57. "no"
58. "no"
59. "management information systems/software thatare used by SPO and contractors to maintain a decision data base and help track program activities"
60. "Yes, discussion of outside influeneces on schedule management, i.e., use changes requirements, budget cuts, new OSD direction, slips in supporting/supported systems (e.g. launch of a satellite), etc."
61. "Yes, closer relation between cost estimating and schedule planning; contractos have to do it; why not the govt?"
62. "no"
63. "no"
64. "no"
65. "... we use a computer-based integrated management system (IMS) which is a time-phased plan of events and activities."
66. "We normally don't schedule; we review contractors schedules/CS data; not sure that this measured understanding of implications as opposed to *how to*"
67. "no"
68. "this was a good survey - maybe ask for % who use MAC Flow, MS Project, MS Project Pro, etc"
69. "no"
70. "not really"
71. "no"
72. "Usually before being able to *define tasks to be performed* there is a step, it has to do with understanding the task needed to be performed and some feel for cost, schedule, performance associated with the task. No where is this addressed in a program. It is assumed that the PM will know or will assemble a team that knows what needs to be done, and how much it will cost, etc. This knowledge is very lacking today."

73. "nothing on interface with customer/user; in C4I systems they control schedule and operational configuration"
74. "no"
75. "no"
76. "I felt this was a very comprehensive survey of scheduling skills."
77. "no, survey was complete"
78. "You got them all."
79. "Yes. Link to APB."
80. "No. I believe you covered most of the available tools I'm familiar with."
81. "no"
82. "understanding benefits/drawbacks/need for various schedule management tools"
83. "no"
84. "no"
85. "no"
86. "I feel one skill I need further training in is true ability to construct more accurate schedules. The process seems to be more of a guess than one that uses historical data to construct meaningful schedules."
87. "no"
88. "no"
89. "interdependencies on other schedules; we live in a very concurrent world."
90. "prioritization of tasks, i.e., omit less critical tasks"
91. "need to integrate into IMP/IMS/IPD concepts/philosophy"
92. "need to emphasize *config mgt* of schedule info in software tools (like MS Project -- both at program office and contractor level)"
93. "being able to link your integrated master plan to an integrated master schedule; lower tier scheduling and flow up to IMS"
94. "no"
95. "no"
96. "no"
97. "no"
98. "no"
99. "yes, intelligence, intuition, and common sense"
100. "As a program manager, I deal with schedules, but I have a schedule manager that actually manages the schedule!"

Most Important Competencies

1. "monthly progress reports"
2. "process reviews"
3. "direct and continuous liaison with contractor (this is done either in person of by phone)"
4. "the ability to produce a readable, realistic schedule and manage to it"
5. "understanding the relationships between tasks"
6. "deconflicting various schedules to meet a common objective"
7. "computer software analysis"
8. "timely flow of information that supports schedules"
9. "identify the critical milestones to develop value added, credible schedules"
10. "tracking the critical path"
11. "getting contractors to take action to lesson impact of bottlenecks (i.e., add people or test equipment)"
12. "program review with responsible parties"
13. "ensuring ownership of everyone involved to reach the final objectives"
14. "analyzing impact of slips & resource draw down"
15. "defining objective and tasks to meet the objective"
16. "Most important is the thinking through og the precedence relationships and the validity of the estimates."
17. "developing a plan with an associated schedule"
18. "Regularly communicating with individuals and organizations involved on the status of activities associated with the plan and schedule."
19. "Knowing what it is you are suppose to do and knowing without question How to do it!"
20. "Motivating people to do the tasks necessary to succeed."
21. "planning - prior planning prevents piss poor performance"
22. "leadership - keeps people focused and committed towards product and customer"
23. "Execution of the planned schedule doing a disciplined agreed-to process."
24. "Interface with contractors to understand the schedules -- mgt reviews, telecons, VTCs."
25. "Ability to ID key milestones from multiple events in order to properly guage progress. Critical events/tasks should be prioritized vs being of equal importance."
26. "Figuring out what needs to be done, how long each takes, and how everything is related. This can only be done effectively using a team approach."
27. "interpretation of CSSR/CPR data"
28. "Schedule evaluation and work arounds"
29. "constructing information briefings to relay schedule status
30. "Impact of schedule delays/changes to overall effort"
31. "A 30 day and 120 day activities chart. A must! Previewed at every team mtg"
32. "first a clear understanding of the objectives; frequently (weekly) mtgs are held with task leaders, plus "formal" management reviews"
33. "using indices to monitor performance & reviewing progress against PMB"
34. "define the tasks and determine the sequence (too many people have to agree)"
35. "cost/schedule performance trades"
36. "understanding if the schedule and work content of activities are consistent with each other and working alternatives to make up for schedule slippages"
37. "weekly prayer - I ought to do it more oftern! In most cases only GOD knows what's happening deep inside a contractor's heart (and program). This works!"
38. "understanding the impact of schedule slippages on performance and cost objecteives (35)"
39. "honest, daily communication with the contractor. Most reports are outdated when they are received. Therefore, a PM is in the react mode. This requires more water to put out the fire. Daily communication prevents surprise."
40. "common sense"

41. "CPM & CPR"
42. "Slow time - fast time paradox - what is it? It is the mentality that if you get nine women pregnant, you can have a baby in a month! Understanding the time work takes. Anticipating unknowns and problem solving are underated abilities."
43. "establishing a good original baseline schedule"
44. "task relationship (PERT)"
45. "laying out the tasks in sequence and estimating duration of each"
46. "planning and proper process prioritization and sequencing"
47. "task identification and definition"
48. "ability to determine when corrective actions are required"
49. "most important - #9"
50. "communication"
51. "most important - ability to define tasks"
52. "Coordination/communication of what's in the schedule and how the tasks (inchstones) relate with each other, because in many cases, this defines how the people working tasks must communicate with each other."
53. "Everyone needs to know the vision and how they contribute to it at the task level."
54. "schedule development"
55. "Microsoft Project"
56. "CPM"
57. "Determine work to be performed and just how long it will take to accomplish the task. Too often we get over estimate of cost or time to accomplish task."
58. "Defining tasks properly"
59. "communication with counterparts"
60. "IMP, IMS, and PS5XL"
61. "develop corrective actions to counter unfavorable program variances is most important"
62. "CS and award fee on contract"
63. "PERT"
64. "Constructing schedule and determining critical path is most important"
65. "In the past, I've found that a critical path network that shows linkage between tasks, sequencing, slack times, etc. is an invaluable tool to manage schedules. This type of tool allows a PM to focus on the "schedule breaker issues, and provides red flag indicators for cost, schedule, performance tradeoff needs. Finally, it provides an excellent quick look visual means for anticipating schedule problems, particularly if each task is associated with a specific work group, i.e., if every task for a particular work group has been late to schedule, then you need to look to the future to see if other tasks assigned to that work group are on the critical path."
66. "ability to effectively use project management software (such as Microsft Project)"
67. "understanding the critical activities (CPM) which are the prime drivers to attaining the major program (project) milestones. If schedule is slipping, must *anticipate ahead* of the program impacts (i.e., possible tradeoffs) or if none then *incentivizing* the contractor to put resources to attaining/competing critical activities."
68. "defining the task in measurable milestones"
69. "good automated scheduling tools on network that can produce TV projection or overheads that are readable; a standard ASC planning factor document (doesn't exist)"
70. "Scheduling of upgrades and modifications revolves around PDM cycle impacts are tracked to # of A/C through the whole process"
71. "KISS methodology (keep it simple stupid); simple to build, read, and maintain"
72. "prioritization of tasks with contractor and customer"
73. " defining the tasks is most important"
74. "most important - schedule distinct, measurable, identifiable milestones"
75. "schedule planning"
76. "earned value or CSS"

77. "calculating schedule variance (we have a cost plus contract); determining if corrective action is required"
78. "IMS tracking"
79. "comparison of contract rqmnts to schedule and Gantt flow"
80. "C/SCSC"
81. "once the schedule is laid into a S/W tool; with appropriate tasks, sequences, and durations - using this tool to track & take action on critical path (and near critical path) activities"
82. "risk assessment"
83. "clear definition of tasks to be accomplished within the schedule period"
84. "variations are most important"
85. "detect insufficient schedule to work defined"
86. "defining/deterining for both"
87. "defining meaningful milestones or events; using personal experience base to add realism to schedules"
88. "having the *contractor* develop and use an earned value flow down of all work to individual cost account managers"
89. "establishment and tracking of intermediate (minor) milestone status"
90. "understand content (definition) of work to be done"
91. "risk management - know your contractor, know his capability, understand his failings"
92. "upfront understanding of requirements and accurate estimation of project tasks"
93. "receiving CPR data for each WBS"
94. "having a true *program* level integrated master schedule network based on networks at the project level and using the IMS to *manage* the program"
95. "understanding contractor data and deciding on corrective actions based on that data"
96. "network dependecies and logic (i.e., flowcharting and connecting); also tying ownership at lower subsystem or component levels - be they contractor or gov't ... i.e., the customer often *owns* a facility - and its necessary upgrade!"
97. "*actual completion* of event/milestone vs planned completion, especially if *actual* happened after *planned*"
98. "review schedule and give a reality (credibility) test; integrate across schedules managed by different IPT's?
99. "If I had to pick a single activity it would be PERT."
100. "integration of schedule across programs not part of program to assure connectivity across a large network"
101. "schedule distinct, measureable, identifiable milestones"
102. "contractor performance vs contract"
103. "the balancing of limited resources - this means constantly reviewing and changing people, funding, and test resources"
104. "If working a normal project, it would be breaking WBS into schedule events with precedence and dependencies to perform risk analysis."
105. "I most frequently determine sequence and precedence of project tasks - it is also the most important"
106. "Gantt charts"
107. "performing cost, schedule, performance trade-offs in managing the contract"
108. "management to milestones, i.e., hardware delivery requirements specified by contract"
109. "nothing"
110. "defining the tasks to meet the objective, prioritizing them, and then making assignments"
111. "allocation of resources; CPM"
112. "Identifying distinct measurable milestones is most important in my job."
113. "detecting schedule slips, assessing progress, and determining workarounds"
114. "cost/schedule management and tracking, understanding drivers of the variances and how to work around them"
115. "cost/schedule/performance trades given decreasing funds availability"

116."schedule distinct, measureable, identifiable milestones"
117."integrated master schedule validity and corrective action plans to impact critical path"
118."being able to use MS Project for constant *what-if* exercises"
119."PERT/CPM done at on-set of any major project (but not frequently)"
120."review of critical path"
121."actual task definition and project schedule definition"
122."individual schedules in the area in chich I manage, such as aircraft integration; Both Gantt charts and networks are vital for insight."
123."figuring how to speed up the planned schedule since it is almost always behind the original plan"
124."making briefing charts with schedules"
125."scheduling program milestones and tracking progress in meeting them"
126."understanding the risk associated with duration and interdependencies of task"
127."setting goals and meeting them weekly, monthly, quarterly"
128."computer aided schedule management such as MS Project"
129."frequent internal status meetings"
130."constantly redefining tasks, reviewing tasks necessary to accomplish program objectives"
131."how schedule impacts cost delta and manpower loading. My job involves multiple independent tasks performed by the same contractor."
132."Constructing and project network diagram representing tasks and their precedence relationships is without a doubt the most valuable to me. From there you can capture your schedule risks [and] make detail[ed] evaluation of individual tasks. In other words, it makes the *BIG PICTURE* more manageable. It makes for a more systematic approach; you don't have to worry about a critical path -- you must complete the preceding task which is a given. It gives you an almost physical view as opposed to an abstract view."
133."schedule execution is most important"
134."user and program office interface - schedule are worthless unless you understand the need of your customers. This drive[s] all the schedule mgt activities."
135."cost/schedule/performance tradeoffs"
136."The use of PERT networks and CPM analysis I have found to be the most useful. My current duties do not involve calculating variances or earned value. However, these are important in determining cost performance."

Most Used Competencies

1. "high risk critical path activities are most used"
2. "most frequently monitor with 100-level mgr vs cost report"
3. "targeting bottlenecks along the critical path"
4. "Most frequently used is whatever the audience is percieved as wanting to hear!"
5. "gantt chart development"
6. "gantt chart is most frequently used"
7. "most frequent - #26"
8. "most used - determine corrective action to variances"
9. "schedule development"
10. "CPM"
11. "#31-36 are most frequently used"
12. "The one I use most frequently is schedule management software tools."
13. "CSS - look at it weekly"
14. "most frequently used - determine if schedule variation requires corrective action"
15. "most frequently used activity is constructing information/status briefings"
16. "CPR"
17. "critical path analysis"
18. "working groups or program reviews where task completion is statused"
19. "define taks to be performed to meet objectives"
20. "assess progress (milestone accomplishment and earned value)"
21. "continuous dialogue with contractor is best tool available"
22. "The one I use most frequently is schedule management software tools."
23. "allocate scarce resources over the period of the project"
24. "I most frequently determine sequence and precedence of project tasks - it is also the most important"
25. "I would say that milestone schedules are used most frequently in my organization."
26. "daily cost/schedule/performance trades"
27. "Most frequently used is estimating task duration."
28. "schedule statusing to higher-level managers done at least monthly, usually more often"
29. "Reviewing contractor cost/schedule data is probably the most frequently used."
30. "integrating cost/impacts vs payoff"
31. "*Unfortunately* much time is spent briefing rather than doing!"

Other Comments

1. "most program management personnel do not perform management activities; difficult to assess "
2. "relevance of survey"
3. "I hope ASC is not trying to build a schedule fiefdom. I think contractor/program offices should use the same scheduling system and share electronic access to this system. We manage paper, the contractor builds the weapon system. We do not need to add another layer of bueracratic oversight."
4. "Every quarter our program goes through a "what if" exercise. Having a linked schedule maintained by government personnel is essential."
5. "Who is responsible for schedules in AFMC these days? It should be the contractor. Why are all these program managers building schedules. The contractor should build them and we should hold them to it!"
6. "Cost estimates for new project go from best quess to "ink & POMed." There is usually little time for refinemed estimates and schedules."
7. "Schedule management" in a vacuum is no better than "Cost control" or shasing perfection.mmThey only truly manage in the balance."
8. "Using Air Force acquisition model enhances efficiency of action
9. "All of the identified have some importance based on experience and relevance to an individual's or organization's unique situation."
10. "no"
11. "Get your paper done before you retire!"
12. "Too much emphasis on techniques (i.e., PERT) and C/SCSC - not the way real day to day schedule mgt is done."
13. "We too often try to network every event in a project. Should pick out key events & some spans to track."
14. "Many of the tasks/skills you asked about are not accomplished by the governement. The contractor does it and the government reviews what the contractor reports. If a contractor gets in a loss situation (not an uncommon occurrence) the CPR/Cost report stuff is useless. Knowing that something really needs to be done, when cost and schedule variations develop, and what needs to be done are ultimately the most critical skills -- these skills are not taught very well or can't be taught."
15. "Schedule Performance Indicator (SPI) isn't best schedule indicator, refer to A-12 "lessons learned."
16. "I spend the majority of my time in communicating schedule status to the Pentagon, OSD, etc. The better I communicate, the better off we are."
17. "skills once known - long forgotten, Refresher course at 15/20 yr point would be very helpful"
18. "you can't manage by just referencing contractor reports. You need to live with the contractor."
19. "I don't find the tools as useful as experience or experienced people on the team. Using the IPT may be the most important skill"
20. "Obviously there are some differences between technicians who computes, constructs schedule, variance etc., and program manager that analyzes the data and reacts to variances, slippages, etc"
21. "Do you guys do anything with this stuff? Does successful management mean understanding or execution? Do you know the difference between someone who does arithmetic and mathmatics? If you do then you underatnad what should be added to your questionaire."
22. "None"
23. "The majority of my tasks are associated with monitoring and managing an existing test program. Others in SPO are charged with schedule simulations, CPR, etc. On the special projects I've worked there usually is too much emphasis on speed to sit down and do a good job of using the techniques mentioned in this survey. My major complaint is that we do too much reporting of what we do than doing it! (#19, 20, 26, 47, 48, 54). I'd use schedule mgt software tools if I could get the training."
24. "There are some avenues of PM you have omitted. A pure evaluation of routine activities shows a distinct lack of appreciation of what exactly program mgt entails"
25. "don't personnaly use many skills -- have staff do this for me"

26. "This survey is strongly biased towards program management (as it should be). Long range planners often used a different set of tools to deal with uncertainty, i.e. QFD or AHP. In this regard, micromanagement of schedules is not required."
27. "I attended CSCSC/CSSR courses early in my PM career - was moved out of career and then back in. There is no means available or courses available to brush up skills or to learn new inovations or techniques. Should be some course offerings to middle/upper level career people to address new approaches, policy, etc."
28. "Schedule is important up to a point. However, *activity based* program performance is crucial for program success. Building a schedule and budget to complete required activities is a critical PM function."
29. "None"
30. "many items were considered very important in a normal development program - not FFP WDI program"
31. "time estimate for completing this survey was severly under estimated"
32. "I'd appreciate getting surveys earlier than 2 days before they're due -- especially when they're dated 6 weeks earlier!"
33. "schedule management & WBS are fine but it takes dedicated manpower to support"
34. "To know you have schedule problems requires an understanding why and how your schedule troubles evolved."
35. "need to discriminate between development scheduling and production scheduling - different skills, techniques, risk factors; need both"
36. "Your cover letter states that this survey will take approx 12 minutes -- its not likely that anyone is going to read your instructions, read a question, give meaningful thought to an answer, and record the answer on the form, at the rate of 5-6 questions per minute!"
37. "The biggest challenge is to make sure the schedule the program office, the user, and the prime contractor are the same."
38. "This organization manages mostly fixed-price contracts for delivery of hardware to a defined schedule and works corrective actions and considerations in the event of late deliveries. It is not the standard project management, scheduling, resource allocation, implementation type of activity."
39. "I've spent 17 years in the acquisition business and for all of these 17 years I've watched senior leadership improve processes on officers as a substitute for intelligent management (not leadership) practices. When will they learn?"
40. "It was hard to tell on some of the questions whether you were asking about our internal PM schedules or the contractor's schedule."
41. "Questions on frequency are very dependent on the status of your program. Programs in termoil use the tools much more frequently than program s running smoothly and within cost."
42. "need to upgrade all IPT members, especially FM, to be able to use schedule software tools and integrate with cost tools (financial and cost analysis/estimating) for quick, integrated responses."
43. "Section two was labled as PM skills, yet very skewed toward schedule. There a other PM skills which are more/less important than scheduling skills."
44. "ASC needs an expert system (computer model) to assist program managers in planning realistic schedules. This system should be based on the experience and historical data from previous programs. This is important in this time of downsizing."
45. "None"
46. "Definition of some of the specific techniques woul have been helpful as the techniques can be used and the name forgotten."
47. "Questions of user or delivery impact could have be[en] addressed because this is key to schedule management."
48. "Keep the management approach simple but all must understand the accomplishment of tasks or the time it takes depends on budget, schedule, people, resources, and the political climate. A good program manager would'nt just look at the time it takes as only a function of the technical risks."

49. "Stock and teach MS Project management tool as acquisition standard at DSMC and at each product center."
50. "Most of these questions relate to programs that are already on contract. My projects are all in a pre-contract phase."
51. "We let the contractor manage the schedule and only use *schedule tools* to evaluate trade offs.

Bibliography

A Guide to the Project Management Body of Knowledge (PMBOK) Exposure Draft. ed. PMI Standards Committee. Drexel Hill: PMI, (August 1994).

Acker, David A. Acquiring Defense Systems, A Quest for the Best. Ft Belvoir VA: Defense Systems Management College, 1993.

Acquisition Management Functional Board (AMFB). Executive Secretary: Jesse Stewart. Competency List for the Program Management Career Field, 1993, Unpublished. Ft Belvoir VA: Defense Systems Management College.

American Institute of Aeronautics and Astronautics, Inc. (AIAA), Acquisition of Defense Systems. Ed. J.S. Przemieniecki. Washington DC.: AIAA, 1993.

Baker, Bruce N. and David L. Wilemon. *A Summary of Major Research Findings Regarding the Human Element in Project Management*, A Decade of Project Management: Selected Readings From the Project Management Quarterly. Ed. John R. Adams. Drexel Hill: Project Management Institute (PMI) 1981.

Baumgartner, John S. Project Management. Homewood IL: Richard D. Irwin, Inc., 1963.

Baxter, Brent R., and Kurt R. Bolin. Cost Management Competencies for Department of Defense Program Managers. MS thesis, AFIT/GSM-94S2. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1994 (AD-A285026).

Beck, Joe. *Time Management*, in Project Management Body of Knowledge (PMBOK). ed. PMI Standards Committee. Drexel Hill: PMI, (March 28, 1987).

Best, Gregory D. and Korina L. Kobylarz. Establishing a Department of Defense Program Management Body of Knowledge. MS thesis, AFIT/GSM-91S. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1991 (AD-A246625).

Bloom, Benjamin S. Taxonomy of Education Objectives: The Classification of Education Goals, Handbook 1: Cognitive Domain. New York: David McKay Company, 1956.

Bubshait, Khaled A. *Project Characteristics That Influence the Implementation of Project Management Techniques: A Survey*, Project Management Journal, 23: 43-46, (June 1992).

Capaccio, Tony. *New Reports Track Stealth Missile Woes*, Defense Week, (February 6, 1995).

Cavendish, Penny and Martin D. Martin. Negotiating and Contracting for Project Management. Drexel Hill PA: PMI, June 1987.

Cheney, Dick. (Secretary of Defense) Annual Report to the President and the Congress. Washington DC.: Government Printing Office, 1993.

-----. Defense Management Report to the President. Washington DC.: Government Printing Office, 1989.

Christensen, David S. and Scott R. Heise. *Cost Performance Index Stability*, National Contract Management Journal, 25:7-15 (1993).

Conover, W.J. Practical Nonparametric Statistics (Second Edition). New York: John Wiley & Sons, 1980.

Department of Defense. Defense Acquisition Education, Training, and Career Development Program. DOD Directive 5000.52. Washington DC.: GPO, 25 October 1991.

-----. Career Development Program For Acquisition Personnel. DOD 5000.52-M. Washington DC.: GPO, November 1991.

-----. Glossary: Defense Acquisition Acronyms & Terms (Fourth Edition). Ft Belvoir, VA: DSMC, September 1991.

Devore, Jay L. Probability and Statistics for Engineering and the Sciences (Third Edition). Pacific Grove CA: Brooks/Cole Publishing Company, 1991.

Drezner, Jeffrey A. and K. S. Giles. An Analysis of Weapon System Acquisition Schedules. Santa Monica CA: The Rand Corporation, December 1990 (R-3937-ACQ).

Einsiedel, Albert A. *Profile of Effective Program Managers*, Project Management Journal, 18: 51-56 (December 1987).

Emory, William C. and Donald R. Cooper. Business Research Methods (Fourth Edition). Homewood IL: Richard D. Irwin, Inc., 1991.

Fulghum, David A. (1993, May 24). *ATARS Threat Signals Industry Crackdown*, Aviation Week & Space Technology, 138:, 60 (24 May 1993).

Gadeken, Owen C. *DSMC Studies Program Manager Competencies*, Program Manager, (January-February 1989).

-----. *The Right Stuff*, Program Manager, (September-October 1989).

Gadeken, Owen C. and Duane Cromwell. *Program Management Training in Defense Industry*, Program Manager, (January-February 1991).

Gadeken, Owen C. and Others. *Program Managers With the Right Stuff*, Program Manager, (May-June 1990).

Gansler, Jacques S. Affording Defense. Cambridge: The MIT Press, 1989.

Hersey, P and K. H. Blanchard. Management of Organizational Behavior. Englewood Cliffs NJ: Prentice-Hall, 1977.

Kachigan, Sam K. Multivariate Statistical Analysis: A Conceptual Introduction. New York: Radius Press, 1991.

Kandebo, Stanley W. *NASP Canceled, Program Redirected*, Aviation Week & Space Technology, 138: 33-34 (14 June 1993).

Kanungo, Rabindra N. and Sasi Misra. *Managerial Resourcefulness: A Reconceptualization of Management Skills*, Human Relations, 45: 1311-1332 (December 1992).

Kerzner, Harold. *Formal Education for Project Management*, A Decade of Project Management: Selected Readings From the Project Management Quarterly. Ed. John R. Adams. Drexel Hill: Project Management Institute (PMI) 1981.

-----. Project Management: A Systems Approach to Planning, Scheduling, and Controlling. New York: Van Norstrand Reinhold Company, 1979.

Levinson, Harry. *Criteria for Choosing Chief Executives*, Harvard Business Review, 58: 113-120 (July-August 1980).

Mavroules, Nicholas. *Creating a Professional Acquisition Workforce*, National Contract Management Journal, 24: 15-23 (1991).

Meister, David. Behavioral Analysis and Measurement Methods. New York: John Wiley & Sons, 1985.

Morrocco, John D. *Pentagon Report Faults USAF C-17 Program Officials*, Aviation Week & Space Technology, 138: 62-63 (25 January 1993).

Mueller, Frederick W. *Education for Project Management*, A Decade of Project Management: Selected Readings From the Project Management Quarterly. Ed. John R. Adams. Drexel Hill: Project Management Institute (PMI) 1981.

O'Brien, James, J. *Project Management: An Overview*, A Decade of Project Management: Selected Readings From the Project Management Quarterly. Ed. John R. Adams. Drexel Hill: Project Management Institute (PMI) 1981.

Perry, Robert., Giles K. Smith, Alvin J. Harman, and Susan Henrichsen. System Acquisition Strategies. Santa Monica CA: The Rand Corporation, June 1971 (R-733-PR/ARPA).

Pettersen, Norman. *Selecting Program Managers: An Integrated List of Predictors*, Project Management Journal, 22: 21-25 (June 1991).

Posner, Barry P. *What it Takes to be a Good Project Manager*, Project Management Journal, 18: 51-54 (March 1987).

Project Management Institute (PMI). Project Management Body of Knowledge (PMBOK). Ed. PMI Standards Committee. Drexel Hill: PMI, (March, 1987).

Project Time Management, in A Guide to the Project Management Body of Knowledge (PMBOK). ed. PMI Standards Committee. Drexel Hill: PMI, (August, 1994).

Rosenberg, Eric. *Wall Street Reacts to A-12 Claims Court Decision*, Defense Week. (3 January 1995).

Scott, William B. *NASP Program Battles Congressional Dissent*, Aviation Week & Space Technology, 138: 22-23 (10 May 1993).

Simon, H. A. Administrative Behavior. New York: The Free Press, 1976.

Smith, Bruce A. *Management Miscues, Delays Snarl C-17 Program*, Aviation Week & Space Technology, 138: 30 (12 April 1993).

Smythe, Ralph E, and William J. McMullan. An Evaluation of the Major Qualifications Desired of Air Force System Program Managers. MS thesis, AFIT/LSR-75A. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, January 1975 (ADA006360).

Statistix: Version 3.5. St Paul MN: Analytical Software, 1991.

Stukenbruck, Linn C. *Educating Potential Project Managers*, Project Management Journal, Special Summer Issue: 11-16 (August 1984).

-----. *Project Management Framework: An Overview of the Project Management Body of Knowledge*, Project Management Journal, Special Summer Issue: 25-30 (August 1986).

-----. *The Effective Project Manager*, A Decade of Project Management: Selected Readings From the Project Management Quarterly. Ed. John R. Adams. Drexel Hill: Project Management Institute (PMI) 1981a.

-----. The Implementation of Project Management: The Professional's Handbook. New York: Addison Wesley, 1981b.

Thamhain, Hans J. *Developing Project Management Skills*, Project Management Journal, 22: 39-44, 53 (September 1991).

Thornberry, Neal E., et al. *The Project Manager: What It Takes to be a Good One*, Project Management Quarterly: 73-76 (March 1983).

TSSAM Terminated for 'Convenience,' Aviation Week & Space Technology (AWST), February 20, 1995.

Velocci, Anthony L. *C-17 Termination Could Be Mixed Blessing for Builder*, Aviation Week & Space Technology, 138: 29 (22 March 1993).

Webster. Merriam Webster's Collegiate Dictionary (Merriam) (Tenth Edition). Springfield MA: Merriam-Webster, Incorporated, 1993.

Wideman, R. Max. *The Framework* in Project Management Body of Knowledge (PMBOK). Ed. PMI Standards Committee. Drexel Hill: PMI, 1 September, 1987.

Vita

Captain Jeffrey F. Brown was born on 26 September 1957 in Batesville, Indiana. He graduated from Brookville High School in Brookville, Indiana in May 1975 and enlisted in the Air Force in September 1975. He served as enlisted, holding grades E-1 through E-5 at locations including Beale AFB, California, Kadena AB, Okinawa, Japan, and Lowry AFB, Colorado. He obtained his first Bachelor of Science degree in Electrical Engineering from the University of Colorado at Denver in July 1986 and was commissioned a Second Lieutenant through Officer Training School in November 1986. His first assignment as an officer was at Wright-Patterson AFB Ohio. His first duty was as Avionics Systems Engineer for the B-2 System Program Office where he integrated and tested the on-board electronics in preparation for flight test, designed the in-flight replanning system, and led an $80 million cost reduction initiative replacing out-dated and expensive on-board memory with state-of-the-art optical storage devices. Since May 1992 he has served as Program Manager for the Reconnaissance System Program Office where his small acquisition team has won numerous awards for demonstrating war-fighting concepts in operational exercises. Both efforts have led to major product improvement programs and have dramatically changed Air Combat Command's concept for fighting wars. Captain Brown began attending the School of Systems and Logistics, Air Force Institute of Technology, on a part-time basis in May 1991.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1995	Master's Thesis

4. TITLE AND SUBTITLE
SCHEDULE MANAGEMENT COMPETENCIES FOR DEPARTMENT OF DEFENSE PROGRAM MANAGERS

5. FUNDING NUMBERS

6. AUTHOR(S)
Jeffrey F. Brown

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology
Wright-Patterson AFB, OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GSM/LAP/95S-9

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
ASC/CY
Bldg 2041
2511 L. St.
Wright-Patterson AFB, OH 45433-7503

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

With ongoing public scrutiny of defense system acquisition, due to numerous program failures resulting from cost and schedule overruns, now, more than ever, cost and schedule-management competencies are critical to program success. This research examined the schedule-management competencies required of defense program managers.

A schedule-management competency model was developed from a foundation of past research. The model was evaluated through a mail survey of 484 intermediate and senior level military program managers assigned to Air Force Materiel Command.

The responses provided by 243 program managers indicate that 25 of the 28 competencies in the model were valuable to program managers and that they generally rely more on understanding schedule management competencies than they do on being able to complete the tasks themselves. Data analysis identified differences in the perceived importance and frequency of use based on acquisition phase, primary responsibility, and grade level of the program manager.

14. SUBJECT TERMS	15. NUMBER OF PAGES
acquisition, competencies, program manager, schedule-management	157
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unclassified